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Contents

News of the Industry 709
Business in Brief 714
Automotive Abstracts 715
Tools of Tomorrow 718
Calendar of Coming Events 719
University of Michigan Automotive Laboratories. *By Joseph Geschelin* 720
Just Among Ourselves 723
Determining Bearing-Film Temperature. *By C. G. Williams and J. Spiers* 724
Production Lines 729
Specifications of American Diesel and Other Heavy Oil Engines 730
Specifications of Foreign Diesel and Other Heavy Oil Engines 732
University of Nebraska Tests Graham-Bradley Tractor 735
Advertisers' Index 36

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AUTOMOTIVE INDUSTRIES is read each week by general executives, production men, engineers, purchasing agents and others whose o.k. means orders for those who sell to The World's Largest Manufacturing Industry.

Mechanics

MECHANICS UNIVERSAL JOINT DIVISION
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Announcing
Inland Ledloy

(Patents Applied For)

The Remarkable New Lead-Bearing, Free-Cutting Open Hearth Steel

Today's biggest news in the steel and metal working industries is Inland's development of Ledloy. Here are the important facts:

Inland Ledloy is a new open hearth steel with machinability improved 30% to 60%. It will machine even better than the best free-cutting steels now commercially available, including high sulphur Bessemer screw stock.

Inland Ledloy contains a small percentage of lead, which is added by a special process. The lead is in such a fine state of distribution that it cannot be seen under a microscope . . . The addition of lead has no effect upon the physical properties of the steel except to greatly increase machinability. Tool life is also appreciably increased.

Inland Ledloy, therefore, gives the user full advantage of all the desirable physical properties of open hearth steel, such as ductility, high impact values, transverse strength and effective heat-treatment and carburizing . . . with a saving of 30% to 60% in machining time.

Inland Ledloy is reasonably priced and will make important savings in manufacturing costs for its users.

Inland Ledloy can be produced in any rolled form, but is now made exclusively by Inland in hot rolled bars and sold to cold finishers for conversion into screw stock. For the present, it may be practical to serve Central States industries only. However, we expect to make arrangements so that other steel producers may also make Ledloy for complete national distribution.

Write today for the Inland Ledloy Bulletin. If your regular source does not have Inland Ledloy, we will be pleased to have you take the matter up with us.

FOR EXAMPLE

Savings Over Bessemer Stock

(Actual Production Operations)

Case 1. Form, thread, drill, ream and chamfer

	Time per part
High sulphur Bessemer screw stock (SAE-X1112)	43 seconds
Inland Ledloy 1120	33 "
Increased Production	*29.4%*

Case 2. Form, drill, knurl and chamfer

High sulphur Bessemer screw stock (SAE-X1112)	9 seconds
Inland Ledloy 1120	6.7 "
Increased Production	*34.3%*

These laboratory machining tests, involving sawing and drilling, show the increased speeds permitted over plain carbon and alloy steels:

	Time per part
.45% Plain Carbon Steel (SAE-1045)	68 seconds
.45% Carbon Inland Ledloy 1045	51 "
Increased Production	*33.3%*
.85% Carbon Steel (SAE-1085)	72 seconds
.85% Carbon Inland Ledloy 1085	56 "
Increased Production	*28.6%*

Screw machine tests on Inland Ledloy of .45% carbon steel (SAE-1045) show that it machines better than .35% carbon screw stock (SAE-X1335).

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Labor

Frankensteen Loses Directorship of Ford Organizing Committee

Internal affairs of the United Automobile Workers Union featured labor news of the week with the disclosure that Homer Martin, UAW president, had removed Richard T. Frankensteen, vice-president, as director of the Ford organizing committee. Several weeks ago Martin had demoted Frankensteen to a straight vice-presidency from the office of assistant president which he formerly held.

Martin's latest action was interpreted as another step in the disciplining of Frankensteen, who incurred the president's displeasure with the proposal of a plan to eliminate factionalism within the union, although supporters of Martin have explained that the step was part of a general program which has seen all five UAW vice-presidents removed from directorships to make them available for special assignments from Martin. In support of this explanation they point to the unanimous vote of confidence extended to Martin by the international executive board recently.

No announcement has yet been made of a new director for the Ford committee and UAW headquarters

(Turn to page 713, please)

Chrysler's Wallace and GM's Weaver Address Machine Tool Dealers

At the convention of the Associated Machine Tool Dealers of America, held at Dearborn this week, D. A. Wallace, president, Chrysler Sales Corp., took as his topic, "What the machine tool buyer wants to know from the machine tool seller," and covered some of the main sales problems confronting the machine tool organization, concluding with suggestions for improving machine tools.

Mr. Wallace paid tribute to the machine tool industry for its progressiveness and cooperation, and pointed to the future progress that will come as the result of working closer with the factory executives. He emphasized the need for constant improvement as well as the necessity for keeping the buyers acquainted with latest developments.

According to Mr. Wallace, in his own experience the following are troublesome details that must be taken care of in the development of any modern machine tool.

1. Provision for convenient and economical chip removal.
2. Need for improved methods of filtering solutions.
3. Desirability for further improvement in hydraulic mechanism.
4. Need for improving accessibility of machine tool elements in the interest of rapid servicing.
5. Safety features must be anticipated and built into the machine.

(Turn to page 713, please)

HARVEY S. FIRESTONE, JR.

. . . vice-president of the Firestone Tire & Rubber Co., who will act as official referee this year for the twenty-sixth annual renewal of the Indianapolis Speedway automobile race on Memorial Day. This will be the second time that he has served in this capacity, having officiated as referee in 1932.

Production

Week's Car and Truck Output Approximately 48,400 Units

Production of cars and trucks during the fourth week in May stood up better than originally anticipated, with the result that the industry should show a total for the week which will be only slightly lower than the levels maintained during the previous two weeks.

A review of production schedules in effect early in the week indicates that the total output of cars and trucks should approximate 48,400 units, which is only 1400 less than the level maintained during the two previous weeks. With one productive day still left in the month it appears that the total output for May should be slightly in excess of 200,000 cars and trucks.

Official figures just released by the U. S. Department of Commerce show that U. S. and Canadian production of cars and trucks during April was 238,133, of which 219,314 were produced in the U. S. and 18,819 in Canada. Production during the first four months of 1938 has totaled 907,502 cars and trucks, which compares with 1,855,339 during the same period in 1937, a reduction of 51 per cent.

Slight modifications in the schedules of major producers accounted for most of the change in this week's figures. General Motors divisions still lead with approximately 17,300 cars and trucks, followed by Ford and Lincoln with 14,300, and Chrysler divisions with 9700. Studebaker expected an increase of about 400 units over last week's output, while other independents continued at their previous pace.

Graham-Paige resumed production in its body division this week and expected to have finished cars coming off the line by June 1. Orders for domestic and export shipments which have accumulated since the shut-down a month ago have been sufficient to justify resumption of activity.—J. A. L.

Passenger Car and Truck Production

April's passenger car and truck production (U. S. and Canada) of 238,133 units was 620 units less than the total for March, and amounts to only 43 per cent of the 1937 April figure. For the first four months of this year, passenger car and truck production aggregated 907,502 units which is slightly less than 49 per cent of the total for the similar period last year.

	April 1938	March 1938	April 1937	Four Months 1938	Four Months 1937
Passenger Cars—U. S. and Canada					
Domestic Market—U.S.	160,028	153,402	410,592	564,295	1,349,055
Foreign Market—U. S.	16,050	20,749	29,388	81,515	101,086
Canada	14,033	12,276	12,927	51,447	60,924
Total	190,111	186,427	452,907	697,257	1,511,065
Trucks—U. S. and Canada					
Domestic Market—U. S.	31,830	34,696	79,604	134,514	263,072
Foreign Market—U. S.	11,406	13,104	16,566	57,867	60,854
Canada	4,786	4,526	4,154	17,864	20,348
Total	48,022	52,326	100,324	210,245	344,274
Total—Domestic Market—U. S.	191,858	188,098	490,196	698,809	1,612,127
Total—Foreign Market—U. S.	27,456	33,853	45,954	139,382	161,940
Total—Canada	18,819	16,802	17,081	69,311	81,272
Total—Cars and Trucks—U. S. and Canada	238,133	238,753	553,231	907,502	1,855,339

Ford Plant at Riverview, Mich. Making 3000 Tires Daily

Henry Ford's tire plant at Riverview, Mich., is in production with a daily ticket calling for upwards of 3000 tires daily. Installation of tire building machinery is only partially completed and the plant, when completely equipped, will have a capacity of 16,000 tires per day on a two-shift basis of eight hours per shift. This capacity, under normal conditions, will handle about one-half of the Ford Co.'s original equipment tire requirements.

Barrel-Type Engine

New Crankless, 4-Cylinder, 2-Stroke Aircraft Unit Tested at M.I.T.

Tests of a new barrel-type, crankless, four-cylinder, two-stroke aircraft engine were made at Massachusetts Institute of Technology on May 16, in the presence of John H. Geisse, chief, Aeronautical Development Section, Department of Commerce. The engine, which was designed by Heraclio Alfaro and built in cooperation with the Indian Motorcycle Co. of Springfield, Mass., has double opposed pistons, and works with fuel injection and spark ignition. It has a bore of 2 3/16 in. and a double stroke of 3⅜ in., which makes the displacement 157 cu. in. The output is said to be 115 hp. at 2000 r.p.m.

Cylinder axes are parallel to the shaft, and the engine can be built also in an eight-cylinder form. The present engine weighs 240 lb., but the cylinders are of cast iron, and by using materials of greater strength/weight ratio, it would be possible to reduce the weight materially. Single-cylinder tests indicate that this engine may be operated at speeds up to 2900 r.p.m., which would make possible a considerable increase in output. As to future possibilities, it is figured that an eight-cylinder engine of the same cylinder dimensions could be held to within 300 lb. and would develop about 280 hp. at 2400 r.p.m.

Disregarding small projecting pipes and spark-plug tips, the engine has a diameter of 15½ in. Moving parts are in complete dynamic balance, and the engine is said to operate very smoothly. The engine is liquid cooled, and while designs have been prepared for an air-cooled model, it is believed that the liquid-cooled type possesses a balance of advantages; for the eight-cylinder engine referred to in the foregoing, the radiator required would weigh only about 60 lb., which would make the specific weight including the cooling system, 1.28 lb. per hp.

This engine type is said to lend itself well to larger power plants, and designs have been prepared for an engine of 2000 hp. at 1075 r.p.m., which would weigh substantially under 1 lb. per hp.

In the tests, determinations of the fuel consumption were made also, and readings of as low as 0.435 lb. per hp.-hr. are said to have been obtained. The compactness of the compression chamber and the absence of hot valve heads permits of the use of a higher compression ratio, which is said to account for the low fuel consumption. The engine, with a compression ratio of 9.5:1, is said to operate satisfactorily on 72-octane gasoline, producing maximum combustion pressures of up to 900 lb. per sq. in. and b.m.e.ps. as high as 145 lb. per sq. in., which, since the engine operates on the two-stroke cycle, is equivalent to 290 lb. per sq. in. for a four-stroke engine. Oil consumption as low as 0.015 lb. per hp.-hr. was recorded.

In the development of the engine Mr. Alfaro was assisted by the staff of the M.I.T. Engine Laboratory and particularly by Professors C. F. and E. S. Taylor.

Chicago Automobile Trade Association Annual Set for June 13

The annual meeting of the Chicago Automobile Trade Association is set for June 13, according to H. T. Hollingshead, president.

The order of business at the annual meeting will be an election of directors to fill vacancies, and the rendering of reports on activities of the Chicago Automobile Trade Association during the past 12 months.

Liaison Committee

Motor Executive Group to Work With Vehicle Commissioners

Alvan Macauley, president of the Automobile Manufacturers Association has appointed a Liaison Committee to cooperate with a similar group in the American Association of Motor Vehicle Administrators on common problems affecting motor vehicle manufacture and traffic law administration. The motor executives named on the Liaison Committee are: R. H. Grant, vice-president, General Motors Corp. (chairman); R. P. Fohey, secretary, Chrysler Corp.; H. S. Vance, chairman of board, The Studebaker Corp.; R. F. Black, president, White Motor Co.; C. D. Sterling, secretary, Hudson Motor Car Co.; J. R. Davis, sales manager, Ford Motor Co.; A. G. Herreshoff, chairman, engineering relations committee, Society of Automotive Engineers.

The committee of administrators with whom the motor executives will confer was previously appointed by Ray Ingels, president of the motor vehicle administrators national association and is under the chairmanship of Frank Carney, director of the Motor Vehicle Division of the State of Michigan. Other members of this committee are: Wilbur Cross, Jr., technical adviser to Motor Vehicle Commissioner, Connecticut; James Shanley, chief inspector, Department of Motor Vehicles, New Jersey; William R. Sharkey, Jr.,

supervising inspector, California Highway Patrol, W. A. Van Duzer, director of vehicles and traffic, Washington, D. C.; H. C. Comish, assistant vehicle commissioner, Louisiana; Frank West, registrar, Bureau of Motor Vehicles, Ohio.

Six New Mack Trucks

Cab-Over-Engine Models Rated 12,000 to 23,000 Lb. Gross

Production of six new cab-over-engine models with ratings ranging from 12,000 to 23,000 lb. gross has been announced by Mack Trucks, Inc. The new models are designated as EEU, EFU, EGU, EHU, EMU, and EQU.

The EEU, EFU, and EGU are offered in the standard wheelbase length of 107 in. Special wheelbase lengths of 114 in., 126 in., 144 in., and 162 in. are also available in these models. Models EHU, EMU, and EQU are offered in three standard wheelbase lengths: 108 in., 114 in., and 126 in. For the latter three models, there are two special wheelbase lengths of 144 in. and 162 in.

All six models are powered by six-cylinder engines; the EEU engine has a bore and stroke of 3½ in. by 4⅜ in. and develops 75 hp. at 2800 r.p.m.; the EFU, 3⅝ by 4⅜ in. and develops 78 hp at 2800 r.p.m.; the EGU, 3¾ in. by 4⅜ in. and develops 85 hp. at 2800 r.p.m.; the EHU, 3⅝ in. by 5 in. and develops 90 hp. at 3000 r.p.m.; the EMU, 3⅝ in. by 5 in. and develops 90 hp. at 3000 r.p.m.; and the EQU, 3⅞ in. by 5 in. and develops 100 hp. at 2800 r.p.m. Total piston displacement of the models EEU, EFU, EGU, EHU, EMU, and EQU is, respectively, 253 cu. in., 271 cu. in., 290 cu. in., 309.6 cu. in., 309.6 cu. in., and 353.8 cu. in.

Crankshafts of all models have seven bearings and are fully counterweighted on every throw. On the models, EHU, EMU and EQU the crankshafts are case-hardened. Cylinders are all cast-in-block of chrome-nickel steel with detachable one-piece heads.

Drive on all six models is from a dry, single plate clutch, being on the models EEU and EFU through a four-speed, selective, unit-with-engine transmission; a five-speed transmission direct in fifth is available at slight extra cost. On the models, EGU, EHU, EMU, and EQU, drive is through a five-speed, direct, unit-with-engine transmission. In these latter models an over-geared fifth speed is optional. Final drive on all models is of the single reduction type with the exception of the model EQU on which dual reduction drive is used. The models EFU and EGU have a double reduction axle available at slight extra charge. All rear axles are full-floating.

The four-wheel footbrakes on all six models are of the internal type, those on the four smaller models being hydraulic while on the two larger models they are direct mechanical. All have B.K. vacuum boosters as standard except the EEU on which it is offered as an extra. All six models have chassis frames of pressed carbon steel. Cross members for all models are five in number, three of which are of the box girder type.

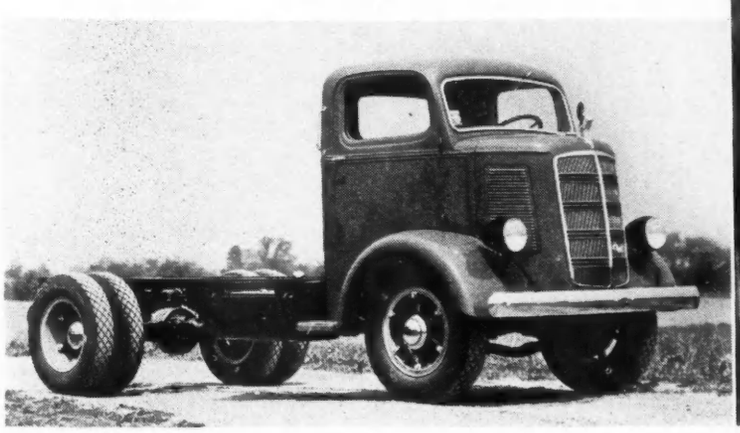
Springs on the models EEU, EFU, and EGU are 42 in. by 2¼ in. in front, 51 in. by 2½ in. in the rear, and helpers are 34¼ in. by 2½ in. On the model EHU, front springs are 44 in. by 2½ in., rear are 54 in. by 3 in., and helpers are 36 in. by 3 in. On the models EMU and EQU, front springs are 42½ in. by 2½ in., rear springs are 53 in. by 3½ in., and helpers are 38 in. by 3½ in.

. . . slants

GASOLINE TAX RECEIPTS—*Gasoline taxes, inspection fees and similar receipts yielded a net revenue of* $761,998,000 *in* 1937, *according to reports of State authorities to the Bureau of Public Roads of the U. S. Department of Agriculture. Similar receipts in* 1936 *totaled* $691,420,000. *Consumption of gasoline on highways amounted to over* 19,000,000,000 *gallons and increased* 7.6 *per cent over the preceding year. Increases were reported in every State except Nebraska and Tennessee.*

EDUCATING FOR SAFETY—*Summer training courses for high school teachers desiring to become instructors in automobile operation and use are being offered by* 39 *American universities and colleges, according to the American Automobile Association. The association has prepared a list of schools offering these courses and also the approximate dates for the sessions.*

INTERIOR of cab (right) on new Mack model EFU cab-over-engine truck rated at 14,000 lb. gross, (below) the EFU chassis.



MEN OF THE INDUSTRY

FOREST H. AKERS has been named vice-president in charge of sales of Dodge Division of Chrysler Corp. Mr. Akers succeeds the late **W. M. PURVES.**

FRANK J. TIMMENS is now general sales manager of the Dodge Division of Chrysler Corp. He was formerly assistant general sales manager of the company.

W. C. COWLING, of Willys-Overland, has been appointed chairman of the committee to nominate directors at the annual meeting of the Automobile Manufacturers Association scheduled for June 9 in Detroit. The other members of the committee are: **HARRY J. KLINGLER,** general manager of Pontiac Motor division, General Motors Corp., and **R. W. RUDDON,** president of the Federal Motor Truck Co.

G. H. GOERING, formerly assistant sales manager of the Blackhawk Mfg. Co., has been named sales manager succeeding **W. P. FERRIS,** who has resigned to go into business for himself.

R. B. SCHENCK, chief metallurgist of the Buick Motor Division of General Motor Sales Corp., was elected chairman of the Saginaw Valley Group, American Society of Metals, at the annual meeting held in Saginaw. Mr. Schenck succeeds **ROY J. GRIFFIN,** chief metallurgist of the Saginaw Steering Gear division, who becomes an ex-officio member of the executive committee.

PAUL R. MARTIN, formerly with the Chevrolet Motor Co., has joined the field staff of the Studebaker Corp.

W. P. GETTY, JR., J. J. COY, and JOHN S. DODGE were recently appointed to the sales staff of the American Screw Co., Providence, R. I. Mr. Getty will cover metropolitan New York and the state of New Jersey. Mr. Coy will cover the Middle West from Detroit, and Mr. Dodge will have the New England territory.

R. J. SCHULER has been added to the general sales organization of the Republic Steel Corp. in the capacity of general sales representative of the Union Drawn Steel division.

PERCY T. OLDHAM has been appointed manager of special sales of By-Products Steel Corp., division of Lukens Steel Co., Coatesville, Pa.

M. S. KLEIN has been named comptroller of United Motors Service.

NIRAN BATES POPE, for 20 years managing editor of *Automobile Topics,* has resigned to become associated with the public relations department of the Automobile Manufacturers Association.

W. E. MILL has joined the American Bantam Car Co., Butler, Pa., as branch manager. Mr. Mill, who will operate from headquarters at the Bantam factory in Butler, was formerly associated with the Federal Truck Co. as New York regional manager. He also has been associated with the Pontiac Motors division of General Motors and with Willys-Overland, Inc.

GM's Overseas Sales Off 4.9 Per Cent in April

Sales of General Motors cars and trucks to dealers in the overseas markets during April totaled 32,957 units, a decline of 4.9 per cent from sales in April of last year.

In the first four months of 1938, sales of 130,150 units were at a record volume level and represented an increase of 7.3 per cent over sales in the first four months of 1937.

For the 12 months through April, 1938, sales totaled 372,355 units, an increase of 12.7 per cent over the volume in the 12 months ended April 30, 1937.

These figures include the products of the corporation's American, Canadian, English and German factories sold outside of the United States and Canada.

Dealer Survey

NADA Study Compares 1937-1936 Operations of Selected Group

Results obtained from a survey which sought comparative data on the operations of a selected group of automobile dealers for the calendar years 1937-1936 are reported in a bulletin recently issued by the National Automobile Dealers Association. As pointed out by the association, the figures contained in the report represent dealers whose operations are considerably above the general average. The reporting dealers averaged $420,640 total sales volume in 1937.

An analysis of the data contained in the report is set forth by the association as follows: 1. New car inventories doubled; 2. Used car inventories declined; 3. Gross margin increased by 4.35 per cent; 4. Total expense increased by 7.60 per cent; 5. New car dollar sales volume declined; 6. Used car dollar sales volume increased; 7. Used car gross loss declined; 8. Reporting dealers did 17.79 per cent of their gross sales in other departments, compared to 15.78 per cent in 1936; 9. On the sales in other departments they made a gross margin of 36.55 per cent compared to 23.42 per cent on new cars and a gross loss of 6.85 per cent on used cars; 10. Reporting dealers had an operating loss of $6.59 per new car sold, in their new and used car departments, after crediting $8.02 from finance reserve earned.

The association concludes, "The business of selling automobiles at retail cannot be divorced from the service and parts departments if the dealer expects to make a net profit. The one enhances the value of the other. The combined new and used motor vehicle selling alone is not generally profitable. This is, of course, due to the used car operation which consumed 52.71 per cent of new car gross. A dealer sells new and used cars to owners who become customers of the service and parts departments, and in turn the latter become prospects for new and used cars. Consequently, a balanced operation is essential."

France Establishes New Import Quotas on Trucks and Parts

The Commerce Department reported last week that France had established new import quota restrictions on motor trucks, truck chassis, bodies and parts.

The quarterly quotas for imports from all sources were fixed at 303 metric tons for complete trucks and 201.4 metric tons for truck chassis. The allotments to individual countries were not published. Licenses will be granted to French importers on the basis of their 1937 imports, the department said.

April Foreign Sales of Tractors and Parts Gain 36%

Foreign sales of tractors and parts during April aggregated $5,920,282, 69 per cent of the total farm equipment exports and a 36 per cent gain over the corresponding 1937 shipments amounting to $4,351,970, according to the Machinery Division, Department of Commerce. Wheel tractor sales improved by 41 per cent to $3,093,793 compared with $2,191,720 in April, 1937, and tracklaying tractors by 26 per cent to $1,789,842 from $1,421,887.

In the wheel type, shipments were divided over the three size classifications as follows: 14 belt hp. and under, $111,333 against $80,497 in April of last year; 15-32 belt hp., $2,013,584 against $1,414,528; and 33 hp. and over, $968,876 against $696,695. Of the tracklaying tractor shipments, $705,066 consisted of the carburetor type, mostly of the sizes below 35 drawbar hp., and $1,084,776 of the fuel injection type distributed fairly evenly over the three size classifications (under 35, 35-59, and 60 and over drawbar hp.).

The carburetor type sales were up 53 per cent over the April, 1937, exports valued at $461,494, while the fuel injection type were 13 per cent greater than the $960,393 figure recorded a year ago. Practically all of the gain in the fuel injection type sales was made in the smaller and usually the least important export size class (under 35 drawbar hp.), which increased to $318,123, compared with $110,193 in the same month of last year, the Machinery Division stated. Shipments of tractor parts and accessories also showed a substantial gain, to $1,006,951 against $697,128 a year ago.

Nash Sales Crusade

Corporation Will Expand Campaign Launched in Lincoln, Neb.

Inspired by the success of its six-day test campaign in Lincoln, Neb., to break depression psychology through aggressive direct selling efforts, the Nash-Kelvinator Corp. has announced that it will expand its efforts into a National Salesmen's Crusade beginning June 6. Nash dealers will participate actively in the national crusade and all industries, regardless of product, will be urged to have their retailers take part.

The campaign, featuring the slogan, "Sales Mean Jobs," was launched in Lincoln on a trial basis by George W. Mason, Nash-Kelvinator president, on May 18. It received the enthusiastic endorsement and cooperation of retailers in all lines of business as well as of civic, State and Chamber of Commerce officials.

Mason, who is preaching the gospel that increased effort on the part of American salesmen will help swing the pendulum of business back to better times, expressed the hope that the success of the Lincoln trial of his plan "will serve as a guide to other organizations within our own industry and in other industries."

Strongly supported by newspapers and other publicity media the campaign resorted to door-to-door canvassing and door bell ringing with the general public in Lincoln cooperating to the fullest extent and showing an unusual willingness to listen to salesmen as well as to pass along the names of prospects.

The program was strongly supported by distributors of competing makes of refrigerators, Nash officials reported, while car dealers in Lincoln, representing a variety of makes, also joined Nash dealers whole-heartedly in the intensive selling campaign.

Nash-Kelvinator executives took a personal part in the Lincoln drive with Mason himself making 14 calls. Virtually all store windows displayed the emblem of the movement featuring the crusade slogan that "Sales Mean Jobs." All Lincoln residents employed in sales work wore lapel buttons distributed at a mass meeting conducted by the Chamber of Commerce while store fronts and street lamps were decorated with flags and campaign colors.

In addition to major Nash-Kelvinator executives the drive was watched by 25 regional and district sales managers who will assist in expanding the movement nationally beginning June 6.

Monthly Motor Vehicle Production—U. S. and Canada

	Passenger Cars		Trucks		Total Motor Vehicles	
	1938	1937	1938	1937	1938	1937
January	169,447	324,191	54,058	74,995	227,744	399,186
February	151,272	310,961	47,287	72,939	202,872	383,900
March	186,427	423,006	47,800	96,016	238,753	519,022
April	190,111	452,907	43,236	100,324	238,133	553,231
May	.....	443,412	.....	96,965	.....	540,377
June	.....	429,333	.....	91,820	.....	521,153
July	.....	372,913	.....	83,996	.....	456,909
August	.....	317,270	.....	87,802	.....	405,072
September	.....	120,597	.....	55,033	.....	175,630
October	.....	306,040	.....	31,939	.....	337,979
November	.....	309,121	.....	67,508	.....	376,629
December	.....	258,769	.....	88,117	.....	346,886
Total	.....	4,068,520	.....	947,454	.....	5,015,974

Chrysler's Wallace and GM's Weaver Address Machine Tool Dealers

(Continued from page 709)

6. Good-looking machines with good finish are most essential. Psychologically this is essential to good workmanship and good housekeeping. More attention should be given to eye-appeal by all producers.

Henry G. Weaver, director, Customer Research Staff, General Motors Corp., presented before the same group a paper entitled, "Is the Customer Always Right?" Mr. Weaver's answer was, "No! Everybody is liable to make mistakes. So we might say that the purpose of customer research is to find out just what it is that the customer is right about and to find out just what it is that he may be wrong about." In this regard he cited a quotation from a book authored by Kenneth Goode, which states: "Find out what people like, and do more of it . . . Find out what people don't like—do less of it."

Explaining how General Motors seeks to discover customer preferences and prejudices, Mr. Weaver pointed out that the Customer Research Department contacts each year approximately 3,000,000 motorists by questionnaires and personal interviewing. The surveys deal not only with features of design, but with questions relating to sales, advertising, and service.

"From a broad overall viewpoint," said Mr. Weaver, "it would be inadequate to describe customer research as an isolated functional activity because, as Mr. Alfred P. Sloan once expressed it—'in its broad implications customer research is more in the nature of an operating philosophy which, to be fully effective, must extend through all phases of a business — weighing every action from the standpoint of how it affects the goodwill of the institution, recognizing that the quickest way to profits and the permanent assurance of such profits—is to serve the customer in ways in which the customer wants to be served.'"

In his concluding remarks Mr. Weaver said, "It is just as important to learn the facts about the errors of public thinking as it is to learn about the correctness of public thinking, and it is difficult to see how you can direct your public relations activities along the most efficient and intelligent lines unless you know something about what's in the public mind to start with . . . and I'd like to add that one of the most expensive mistakes in business is to confuse what people really *ought to think*, with what people *actually do think*."

LABOR

(Continued from page 709)

has been unwilling to comment on the campaign to organize Ford workers.

Conferences were continued this week between a UAW committee and General Motors officials in reference to the union's complaint that preferred lists provided for in the agreement between GM and the UAW have been abused through the retention of foremen and office workers on production lines at the expense of employes with seniority rights. A week ago the union announced that it had requested appointment of an umpire to settle the dispute but up to the present no umpire has been appointed and UAW headquarters indicated that the conference method now under way was making progress to the extent that an umpire might not be needed.

In Rockford, Ill., five officials of the UAW were fined and sentenced to jail after being convicted of violating a circuit court injunction restraining pickets from interfering with employes at the J. I. Case Co. plant. Their counsel has announced plans to appeal the convictions.

Business in Brief

Written by the Guaranty Trust Co., New York

Little change occurred in the general business situation last week. One index of business activity last week stood at 69.6, as compared with 69.4 the week before, and 105.1 a year ago. Gains were registered by petroleum runs-to-stills, electric output, and bituminous coal production. Retail trade was retarded by adverse weather, and the total was from 3 to 8 per cent below that in the preceding week and from 8 to 15 per cent below that in the corresponding period last year.

Railway freight loadings during the week ended May 14 totaled 541,813 cars, which marks a gain of 5673 cars above those in the preceding week, a decline of 227,747 cars below those a year ago, and a drop of 139,595 cars below those two years ago.

Production of electricity by the electric light and power industry in the United States during the week ended May 14 was 10.3 per cent below that in the corresponding week last year.

According to the F. W. Dodge Corp., construction contracts awarded in 37 eastern States during April amounted to $222,016,000, which marks a decline of 18 per cent below the level in April, 1937, and a fall of 2 per cent below that in the preceding month. There was a rise above the total for the preceding month of 5 per cent in the number of small-house units.

Lumber production during the week ended May 7 stood at 52.5 per cent of the 1929 weekly average. Output and new orders showed little change from the totals of the preceding week, while shipments were considerably smaller. New business was 6 per cent above production, and shipments were 2 per cent higher.

Professor Fisher's index of wholesale commodity prices during the week ended May 21 stood at 81.4, as compared with 80.8 the week before and 80.5 two weeks before.

The consolidated statement of the Federal Reserve banks for the week ended May 18 showed no changes in holdings of discounted bills, bills bought in the open market and Government securities. Money in circulation increased $6,000,000 and the monetary gold stock rose $12,000,000.

The Cyclone Fence Co., Waukegan, Ill., has published its new 1938 **metal conveyor belt** catalog and folder.*

A 180-page tool catalog and manual is now being distributed by the Warner & Swasey Co., Cleveland. It describes a complete new line of **tools for turret lathes** just announced by the company and contains, in addition, collateral information and tables such as recommended cutting speeds and general turret lathe tooling suggestions.*

Joseph T. Ryerson & Son, Inc., Chicago, has issued a new bulletin which gives comprehensive data on its Rycrome and Nikrome "M" **heat treated alloy steels** for heavy duty applications.*

Haveg Corp., Newark, Del., has brought out a new catalog on its line of **corrosion resistant chemical equipment.***

The complete line of "Thor" **portable electric tools** is described in a new catalog just issued by the Independent Pneumatic Tool Co., Chicago. The book supplies descriptions, specifications and prices on the Thor line of universal type electric drills, drill stands, screw drivers, nut setters, tappers, saws, hammers, grinders, polishers, sanders, heat guns, and electric tool accessories.*

"Let Me Tell You About Machine Tools" is the title of a pamphlet prepared by the National Machine Tool Builders' Association, Cleveland.*

Two new small Atlas **backgeared screw-cutting lathes** swinging diameters up to six inches are described in catalog No. 29 released recently by the Atlas Press Co., Kalamazoo, Mich.*

Van Keuren Co., Boston, Mass., has published a 4-page circular covering the construction, operation and applications of its improved **micrometer** which uses light waves to determine pressure of measurement.*

Landis Tool Co., Waynesboro, Pa., recently issued catalog No. N-138 which describes its 10-in. type D, **hydraulic crank pin grinder.***

* Obtainable from editorial department, AUTOMOTIVE INDUSTRIES. Address Chestnut and 56th Sts., Philadelphia.

Raybestos Declares Dividend

Raybestos-Manhattan, Inc., has declared a dividend of 15 cents, payable on June 15 to stockholders of record May 31. The company's report for the quarter ended March 31 shows a net loss of $171,448, after all charges. For the first quarter last year the company reported a net profit of $674,504, which equalled $1.06 a share on 635,500 shares. In the March quarter this year the company provided $188,572 for depreciation.

Conference on Recovery Problems Scheduled for Detroit

In an effort to crystallize and coordinate the varying viewpoints of Government, business and labor, a conference has been arranged for Detroit, June 14, by the National Industrial Advertisers' Association, representing the country's leading manufacturers and the Associated Business Papers, composed of the nation's major business periodicals.

Under the chairmanship of J. H. Van Deventer, editor of *The Iron Age*, the conference has invited leading exponents of Federal, labor, and industrial viewpoints to address the gathering. Acceptance of the invitation has already been received from Donald Richberg, who will give his views on the possibilities and problems of Government cooperation with business in an address entitled "Team Work for Prosperity."

Participating in the organization of this conference are such organizations as the Michigan Manufacturers' Association, Machine Tool Association of Detroit, Screw Machine Products Association, American Welding Society, Society of Automotive Engineers, and the Purchasing Executives Association of Detroit.

The "Industrial Marketing Conference" is under the direct sponsorship of the Detroit Chapter of the National Industrial Advertisers Association in conjunction with the Advertising Federation of America, which will hold its annual convention in Detroit the week of June 14.

Automobile Speed Records

A list of automobile speed records as of April 15, 1938, has just been issued by the Association Internationale des Automobile-Clubs Reconnus. It gives the distance or time to which the record applies, the form of start (standing or flying), the date and the place where the record was established, the name of the driver and the make or name of the car, the time or distance, and the corresponding speed in kilometers and miles per hour.

It is interesting to note that while Eyston holds the flying-start kilometer and mile records, which he established on Bonneville Salt Beds, Utah, with his Thunderbolt, the 5-

and 10-kilometer and the 5-mi. records belong to Sir Malcolm Campbell, who established the 5-km. record with the Campbell Special at Bonneville and the 5-mi. and 10-km. records at Daytona, Fla., with the Campbell Special and the Napier-Campbell Special, respectively. All these records are for flying starts. The 1-km. and 1-mi. standing-start records were established by the late Bernd Rosemeyer on the Reichsautobahn between Frankfort and Darmstadt, where Rosemeyer also established the present 10-mi. flying-start record.

Next come a long series of records held by D. A. Jenkins with his Mormon Meteor, which were established on the Bonneville Salt Beds. These include the standing-start records for 50, 100, 200, 500, and 1000-km. and mile records.

Eyston and Denly together hold three long-distance records, of 2000 and 3000 km. and 2000 mi., made in the "Speed of the Winds" on Bonneville Salt Beds. Of the remaining records up to 10,000 km., all made at Bonneville, some are held jointly by Ab Jenkins and Lou Meyer and others by Ab Jenkins and E. A. Stapp.

The foregoing are unlimited records. Such unlimited records are given for distances up to 300,000 km. and for times up to 133 days. Class records are also given.

40 Years Ago

with the ancestors of AUTOMOTIVE INDUSTRIES

Now the "Motorwoman"

Americans will find it hard to realize how completely the motor vehicle and its kindred sports have taken hold of the French people. Among the upper circles of Paris it is now the fashion nor merely to own a motor carriage, but, if you please, to operate it yourself, even if you be of the gentler sex. The Duchess d'Uzes, a leader of the salons, having just passed the regular examination before the authorities and qualified as a chauffeuse, is frequently seen guiding her carriage in the boulevards. If a woman can ride a bicycle and drive a horse, she can certainly drive a motor carriage.

We believe the Duchess favors the term motorman rather than chauffeur, which means stoker in English, and is rather too suggestive of soot and grime for delicate hands.

From *The Horseless Age*, June, 1898.

AUTOMOTIVE ABSTRACTS

Point of Ignition In Air-Chamber Diesels

The question as to whether in a Diesel engine of the air-chamber type, combustion is initiated in the air chamber or the main chamber, has been investigated experimentally in the combustion-engine laboratory of Munich Technical College by Dr. A. Loschge and Dr-Ing. F. Kneule. The tests were made on an engine of the South-German Brake Works, in which the air chamber communicates with the main chamber through a series of perforations in a plate or insert on which the fuel spray impinges from the main-chamber side. The moments at which combustion began on opposite sides of the plate were determined by the ionized-gap method. Insulated electrodes were inserted through the walls of the air chamber and main chamber respectively, and gaps formed between the ends of these electrodes and the walls were included in the deflection circuits of two cathode-ray oscillographs. Included in these circuits were sources of electromotive force which were unable to break down the dielectric resistance of the gaps when cold, but caused currents to flow across the gaps the moment they became ionized by the presence of flame.

The tests showed that in this type of engine, ignition always takes place close to the hot burner plate, and that with the usual degree of injection advance, it may take place first either on the air-chamber side or on the main-chamber side of the plate. In many cases combustion starts on both sides of the plate at the same time. At part load (2/3-3/4 full load) and late injection (12 deg. ahead of top center), ignition occurs first in the main chamber. An increase in the injection advance tends to shift the point at which combustion begins in the air chamber. The question is of interest not only from the scientific standpoint, but also from the standpoint of patent rights. It had been alleged that with the high compression ratio (16.5) used in this engine, combustion would begin always, or at least in the majority of cases, in the air chamber, and that the air chamber was merely a modification of the conventional precombustion chamber in which combustion of the charge was initiated. The tests made at Munich are said to have disproved this allegation. They are also said to have proven the favorable influence of the hot insert on ignition of the fuel spray.—*ATZ*, April 25.

Goodyear May Establish Factory in Sweden

Goodyear Tire & Rubber Co. is reported to be considering the establishment of a tire factory in Sweden to supply the Swedish, Danish and Norwegian markets. President P. W. Litchfield of Goodyear, with a group of engineers, sailed recently from New York for Stockholm. A tentative site for the Swedish factory is understood to have been selected.

Sweden was America's second largest tire customer in 1937, taking 75,915 tires. Denmark was the United Kingdom's second largest tire customer in 1937, taking 163,789 British tires.

Goodyear now has tire plants in Akron; Jackson, Mich.; Cumberland, Md.; Gadsden, Ala.; and Los Angeles in the United States; in Bowmanville and New Toronto, Canada; and in Wolverhampton, England; Sydney Australia; Buenos Aires, Argentina and Buitenzorg, Java.

New Plant for Manufacture of Tungsten and Allied Products

Cleveland Tungsten Mfg. Co. recently opened a new plant at 10200 Meech Ave., Cleveland, which is said to be the only plant in the United States devoted exclusively to the manufacture of tungsten, its alloys, and products. The plant is now equipped to manufacture tungsten metal by both the hydrogen and the carbon reduction processes.

The former gives tungsten of a high degree of purity, as required for electrical contacts, the electrodes used in atomic hydrogen arc and spot welding, and in X-ray tube "targets." The tungsten produced by the carbon reduction process, which is somewhat less pure, is suitable for use in hard-surfacing of steel, and in hard tungsten cutting tools.

Automotive Metal Markets

Third-quarter Steel Prices Virtually Unchanged; Effort Made to Eliminate Obsolete Quoting Practices

Although announcement of third-quarter steel prices carries a slight downward revision in base prices of hot and cold rolled sheets and hot rolled strip, this is strictly nominal, extras and differentials having been revamped, so as to leave average prices virtually unchanged. This change in the pricing method was prompted by a desire to eliminate obsolete habits of quoting, which led to much confusion and insinuations of price-cutting here and there.

The modern, continuous rolling process has done away with any difference between the product of what is commonly referred to as the strip mill, largely so because of an artificial width classification, and that of the continuous sheet mill. A piece of flat steel, having identical properties with another turned out by somewhat different equipment, whether it be a sheet or strip or plate mill, is the same in the eyes of the consumer, regardless of what differences in production costs may apply, if rolled in one or another type of mill.

The steel producers apparently considered announcement of third quarter prices an opportune moment for further reforms on the road toward simplification of classifications and uniformity. The largest of the independents and several of the smaller producers have followed the leading interest's announcement with virtually identical notices to their customers. So far as the volume of demand is concerned, reaffirmation of current prices for the third quarter has brought no change in the pace. This week's rate of employed ingot capacity, as reported by the American Iron and Steel Institute, shows a further small decline of from 30.7 to 29 per cent. Finishing mills report little improvement.

Pig iron marketers, who were waiting for some announcement by the steel mills of third quarter prices, have followed their lead, and are quoting third quarter shipments at present prices, without automotive foundries showing any more interest than they have in the past few months, during which single carloads made up about all the movement.

Non-ferrous metal prices, except those of tin, turned in buyers' favor in the last few days. Under the influence of a continuing sharp surplus of output over demand, the European copper markets moved downward, this in spite of the possibly greater need of copper for armament as the result of political developments. There is talk of the members of the international copper cartel, now operating at 105 per cent of standard tonnages, cutting output by 5 per cent. The export price at the beginning of the week stood at 8.60 cents. Customs smelters took the lead in marking the domestic price for electrolytic down to 9 cents and mine producers followed suit. In the outside market this level could be shaded by ⅛ of a cent.

Unconfirmed rumors early this week were to the effect that the tin buffer pool plan had been accorded approval in a referendum of the Malayan interests, and on the strength of these reports the London market moved upward, but there was so little demand here that the market for spot Straits on Monday was strictly nominal at 36½ cents. On Tuesday, the International Tin Research Council released figures showing that world consumption of tin in the first quarter of 1938 had declined to 40,700 tons, compared with 51,000 tons in the corresponding quarter of 1937, while output in the first three months of this year was only 3000 tons below that of the corresponding 1937 quarter. Nevertheless the market turned firm and higher on foreign cables, spot Straits being quoted at 37.40 cents.

The price of lead was reduced by $5 a ton on Monday, a larger surplus on May 1 than anticipated, together with a drop in shipments being responsible.

Secondary aluminum producers lowered their prices further, lopping ½ cent per pound off the price of No. 12 alloy.—W. C. H.

Agricultural Engineering

Agricultural engineering dates back to 1896, when the first course in the subject was offered to students at the University of Nebraska by Professor O. V. P. Stout. It was a graduate of the University of Nebraska, Jay Brownlee Davidson, who, in 1905, established and became the active head of the first Department of Agricultural Engineering at any American educational institution, at Iowa State College, Ames. The American Society of Agricultural Engineers was founded at a meeting held at the University of Wisconsin in 1907. Most of the 16 founder members were instructors in agricultural engineering. At the present time the membership of the Society is well beyond the thousand mark. These items of information were given in an address before the National Chemurgic Conference, recently held at Lincoln, Neb., by Arnold P. Yerkes, president of the American Society of Agricultural Engineers.

Letters

to Automotive Industries

The Cost of Alloy Steels

Editor, Automotive Industries:

I read with interest each week your Weekly News Letter and believe that you try to present facts as they are, as free from errors as possible.

I want to call to your attention in the letter dated May 13th, 1938, third paragraph on page 2, as to the cost of alloy steel which you say is somewhere in the neighborhood of $450 per ton, or roughly about 10 times that of ordinary carbon steel.

The price of $450 per ton for alloy steel would represent an average price for stainless steel bars or high grade alloy tool steel bars, but is way out of line for the alloy steels representing the tonnage sold to the automotive trade. These are known as S.A.E. steels. The average base prices are more nearly $75 to $90 per ton, which would be roughly twice the price of ordinary carbon steel. Incidentally a lot of carbon steel bars go into automotive construction.

Reader.

Editor's Note: Apropos to the above, Mr. William Crawford Hirsch, who for approximately 20 years has faithfully supplied our "Automotive Metal Markets" column, in which the statement in question originally appeared, writes as follows:

Editor, Automotive Industries:

. . . . I really should have put the statement that "the cost of alloy steel is somewhere in the neighborhood of $450 per ton or roughly about 10 times that of carbon steel" in quotation marks, it being based on an American Iron & Steel Institute release.

Of course, in this statement, the Institute did not refer exclusively to alloy steels used in automobiles, but to alloy steels in general.

Some of these, the corrosion and heat-resisting alloys of the S.A.E. 30 type chrome-nickel alloys, are quoted at 21 to 34 cents a pound in the form of sheets and strip, which would be considerably more than $450 a ton. Some of the straight chromium alloy steels, in sheets, run as high as 36½ cents a pound.

The ordinary S.A.E. nickel chromium steels will run at around 5 to 8 cents in rolled forms, sheets, etc.—or, say, $110 to $175 a ton.

The average for *all* alloy steels, as given by the Institute, is probably correct.

William Crawford Hirsch.

Artificial Fibres

Editor, Automotive Industries:

With reference to the article on Development of Cellulose Base Artificial Fibres,

published in the May 21 issue of your magazine and ending with the notation "Whether the artificial fibres are being used in automobile upholstering materials in Germany is not mentioned," the following may be of interest to your readers:

The mixture of artificial fibres to natural fibres in certain minimum proportions is compulsory in Germany for all materials, including those that are used for automotive purposes. In fact high percentages of synthetic fibres are adopted earlier and more willingly for automobile upholstering materials because of the progressiveness of the automobile industry as compared to the other industries, particularly in Germany.

I have at hand several samples of German automotive mohairs, whipcords, rugs, etc. made of 25 to 50 per cent synthetic fibres (Zellwolle); these samples are mounted each with a sample of corresponding material made of 100 per cent wool to convince the customers that nothing is lost in the quality.

Other samples, seemingly very satisfactory, are made of 100 per cent artificial fibres, but I understand that they are not used at present in production because the present German production of artificial fibres is not sufficient; large factories are being built to increase the production.

The samples that I refer to were brought to Detroit recently by Dr. O. Happich of Germany and shown to several automobile engineers, who found them outstanding. No export business is contemplated at present, as the cost of the artificial fibres in Germany is comparable to that of natural wool which has paid transportation charges from abroad and very high duty. Still the development is worth watching as the situation may be reversed as soon as the installations are paid for and the production methods are improved.

Artificial fibres are used also for the back of imitation leathers which are 100 per cent synthetic; and for rubberized top materials composed of artificial cotton inside lining, intermediate layer of synthetic rubber (Buna), outside fabric of artificial silk (Kunstseide) possessing all the sheen of mohair used heretofore for the purpose on high class European convertible jobs.

M. CASERTA
Consulting Engineer,
Detroit

"Labor Holiday" Hits Goodrich

First Complete Shutdown Affects 9300 Shop and Office Employes; Negotiations with URW Deadlocked Over Issue of Paid Vacations

With its negotiations with the United Rubber Workers Union deadlocked over the issue of paid vacations, with all its Akron factories and warehouses picketed by the union and with 1500 office workers and employes barred from its offices by strong picket lines, the B. F. Goodrich Co. hurriedly set up emergency offices in downtown Akron office buildings May 24, apparently "digging in" for a protracted siege with labor. Although officials of the URW carefully shunned any use of the word "strike" and termed the episode a "labor holiday," hundreds of Goodrich CIO union men and women barricaded all gates to the Goodrich properties, setting up shanties and lean-to shelters. Wives of the union men immediately established soup kitchens, relaying hot food to the picketers, who reported for duty at their regular factory shift hours.

The Goodrich-URW controversy which has flared spasmodically and has kept all Akron business in a turmoil since early last March, surged to a dramatic climax May 19 when electricians pulled switches, threw the gigantic Goodrich plants into darkness and cut off power from all machines, in protest over layoff notices given 25 veteran electricians. Union officials claimed apprentice electricians had been retained, in violation of the union's seniority rules. Picket lines were hurriedly set up and the incoming midnight shift workers were blocked. They at once reinforced the picket lines. T. G. Graham, vice-president, and a corps of maintenance men managed to enter the plant before all picket lines were established. When 1500 office workers reported for duty the following morning, they were turned back by the union.

The "labor holiday" affects 9300 factory and office employes. It is the first complete Goodrich shutdown. In 1936 Goodyear was closed six weeks by strike of the CIO and a year ago the Firestone Akron factories were closed eight weeks.

When union negotiators conferred with Graham inside the picketed plant, a long list of "grievances" was submitted by the union. Although the immediate cause of the crisis—the layoff notices given veteran electricians—was quickly adjusted through the company's agreement to retain the older men and lay off the apprentices, and although other minor grievances were settled, the negotiations for four days impinged upon the one issue of paid vacations Union leaders are demanding one week paid vacation for five-year workers and two-week vacations for workers with 10 years or more service records. At one stage in the negotiations the company attempted to compromise the deadlocked issue by offering each employe entitled to a vacation a tire for his car in lieu of cash for each vacation week. The union refused the offer.

The Goodrich-URW controversy started when Graham announced that unless the union accepted wage cuts averaging 12.3 per cent the company would be compelled to transfer 5000 jobs out of Akron.

Goodrich Union Approves Pact

The Goodrich URW local voted, May 26, to accept the terms of an agreement designed to end the Akron strike affecting 9300 Goodrich employes. The pact, which must be ratified by company directors, provides no wage cuts, a flexible 32 to 36-hour week, and compromise of vacation pay. It is expected that the plants will resume operations next Tuesday.

Passenger Car Production by Wholesale Price Classes

(U. S. and Canada)

Four Months 1938 and 1937 Compared

	Four Months		Per Cent	Per Cent of Total	
	1938	1937	Change	1938	1937
Under $750	610,980	1,444,163	− 58.7	87.63	95.57
$751-$1000	74,546	48,135	+ 54.8	10.69	3.19
$1001-$1500	9,341	12,449	− 25.0	1.34	.82
$1501-$2000	1,419	4,843	− 70.7	.20	.32
$2001-$3000	782	1,382	− 43.5	.11	.09
$3001 and over	189	93	+103.0	.03	.01
Total	697,257	1,511,065	− 53.9	100.00	100.00

Truck Production by Capacities

(U. S. and Canada)

Four Months 1938 and 1937 Compared

	Four Months		Per Cent Change	Per Cent of Total	
	1938	1937		1938	1937
1½ Tons and less	196,781	324,752	− 39.5	93.60	94.33
2 to 3 Tons	7,051	12,265	− 42.5	3.35	3.56
3½ Tons and over	3,093	3,779	− 18.0	1.47	1.10
Special and buses	3,320	3,478	− 4.5	1.58	1.01
Total	210,245	344,274	− 39.0	100.00	100.00

AMA Gives Luncheon For Sir Stenson Cooke

Sir Stenson Cooke, head of the Automobile Association of Great Britain, was tendered an informal luncheon on May 23, at the Rockefeller Center Luncheon Club, by Alfred Reeves, vice-president and general manager of the Automobile Manufacturers Association. Sir Stenson touched at New York before returning to London after a four months' journey around the world, having spent some little time in Australia and New Zealand.

Among those at the luncheon were: George F. Bauer, secretary of the export committee, Automobile Manufacturers Association; Jerry Ryan, manager, Foreign Travel Division, American Automobile Association; William J. Gottlieb, president, Automobile Club of New York; Edward Weinacht, Southern International Despatch; F. C. Horner, General Motors Corp.; William D. Stewart, president and Harry G. Bragg, manager, Automobile Merchants Association of New York.

Sears Lists Tire Price Cuts In Mid-Summer Catalog

Following its usual custom Sears Roebuck & Co. has reduced prices on tires sold via mail order in its mid-summer "flyer" catalog just issued. The price reductions range from 10 per cent to 15 per cent. The price changes are only on tires listed in the Sears catalog and are not on tires sold through Sears retail stores. The bulk of Sears tire business is done through its stores.

In all probability the industry, as in the past, will ignore the "flyer" price cuts, for they are only temporary.

Montgomery Ward & Co. probably will reduce catalog prices in line with the Sears reductions, in its mid-summer catalog.

War Department Contract To Bell Aircraft Co.

The War Department has awarded a $3,168,265 contract to the Bell Aircraft Co., of Buffalo, for the construction of 13 twin-engined pusher planes of the "airacuda" type.

The new planes will be equipped with new engines designed and developed by the Allison Engineering Corp., of Indianapolis, in collaboration with Army Air Corps engineers.

Their maximum speed a military secret, the new planes will carry a crew of five including a radio operator-gunner and two wing gunners.

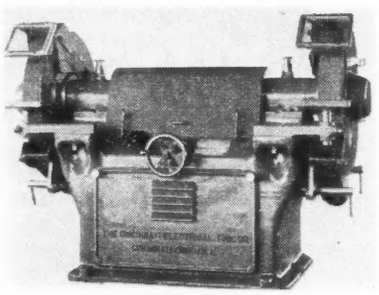
TOOLS OF TOMORROW

Snagging Grinder

. . . Variable-speed unit supplied for either high-speed or vitrified grinding wheels

The Cincinnati Electrical Tool Co., division of the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, has announced a new variable-speed snagging grinder which can be furnished for use with either high-speed or vitrified grinding wheels.

Two adjustable pitch sheaves provide the variable-speed feature, one sheave being mounted on the motor shaft, the other on a counter-shaft within the pedestal of the grinder. To increase the speed of the grinder to compensate for wheel wear it is only necessary to start the motor and turn a handwheel located on the front of the pedestal.



Variable - Speed Snagging Grinder Built by Cincinnati Electrical Tool Co.

As the adjustment of the pitch diameters of the pulleys is synchronized with the movement of the wheel guards and spark breakers, and as the wheel guards move as one unit, it is said to be impossible to over-speed the wheels.

Provision for belt stretch or belt renewal is taken care of by means of two hinged and threaded studs on the front of the counter-shaft assembly which carries the pulleys. The grinder may be had to carry wheels up to 30-in. in diameter with motors up to 15-hp.

Air Cleaner

. . . Lincoln Electric Unit conditions air in vicinity of different shop operations

A machine which conditions air by filtering out dirt particles and which is said to remove approximately 95 per cent of the dirt from the air in the vicinity of grinding, welding and other shop operations, has been announced by the Lincoln Electric Co., Cleveland. It can also be used to draw smoke and heat away from the work.

The "Linconditioner," as the new machine is called, consists of a motor driven fan which produces suction through a flexible metal tube. The fan draws the air through the flexible tube and exhausts it into a filter which is located in the periphery of the power unit. The flexible tube is supported by a welded steel arm and spring arrangement so that the nozzle can be shifted to any desired spot within the operating radius of the tubing.

ICC Authorizes Automobile Rail Rate Revision

A rail rate of 50 cents per 100 lb. on automobiles in straight or mixed carloads from Detroit, Lansing, Pontiac and Flint, Mich., to Chicago, has been authorized by the Interstate Commerce Commission. In applying the rate the carriers will not be required to observe the long-and-short-haul provision of the Interstate Commerce Act, relief from which they asked permission in order to meet truck competition. By disregarding the aggregate-of-intermediate rates, the railroads can now ship from Michigan points by way of Chicago to points beyond at rates lower than through rates from Michigan points to similar destinations.

Olds and Pontiac 1939 Lines to Include 8-Cylinder Models

Both Oldsmobile and Pontiac divisions of General Motors will continue to include eight-cylinder models in their lines in 1939, it was learned through announcements made from division headquarters this week.

"Pontiac Motors will definitely continue to build an eight-cylinder automobile in 1939," said H. J. Klingler, general manager of the Pontiac Motors division. "This eight-cylinder volume comprises a valuable and growing part of our business, and we expect to make it even

larger during the 1939 model run.

"While most rumors that originate in the automobile industry don't merit the importance of a denial, one has been so persistent that I feel it needs an official correction. That is the rumor regarding the possible restriction of our lines of cars for next year."

C. L. McCuen, president and general manager of the Olds Motor Works division, has advised Oldsmobile dealers by letter that the line will continue to include eight-cylinder jobs.

April New Automobile Financing Sagged Approximately 55%

The dollar volume of retail financing of new passenger automobiles showed a decrease of about 55 per cent for the month of April as compared with April, 1937, and a decrease of 59 per cent compared with April, 1936, according to preliminary estimates by the Department of Commerce. As compared with March, 1938, there was an increase of 8 per cent.

All percentages presented below are based on daily average figures with each business day of the week weighted according to the relative volume of business as determined by experience in the trade. Comparison of April, 1938, with the same month of previous years and the percentage changes from March to April in past years are shown below.

Comparisons of April, 1938 with the same month of previous years

April, 1938 was

54.7	per	cent	lower	than	April,	1937
59.1	"	"	"	"	"	1936
34.0	"	"	"	"	"	1935
21.7	"	"	"	"	"	1934
64.1	"	"	higher	"	"	1933
55.7	"	"	"	"	"	1932
30.5	"	"	lower	"	"	1931
47.8	"	"	"	"	"	1930
57.2	"	"	"	"	"	1929

March-April Changes

Percentage Change from March

April,	1938	+ 8.2
"	1937	+ 6.9
"	1936	+24.9
"	1935	+17.4
"	1934	+37.3
"	1933	+54.3
"	1932	+21.4
"	1931	+30.6
"	1930	+24.5
"	1929	+19.9

These estimates on automobile financing are based upon figures reported to the Bureau of the Census by a sample group of large finance companies that have been in continuous operation since 1929. The dollar volume of these organizations represents over three-fourths of the automobile finance business written by all finance companies reporting to the Bureau of the Census and the early receipt of their figures makes it possible for the Bureau of Foreign and Domestic Commerce to make monthly estimates somewhat in advance of the regular reports.

Tires For Sears' Southern Market To be Made at Natchez, Miss.

Sears Roebuck & Co. which, since termination of its Goodyear tire contract two years ago under the Robinson-Patman Act, has had its private brand tires made by several small manufacturers, will concentrate tire production for its southern market in Natchez, Miss., in a plant with capacity of at least 2500 tires per day. The city of Natchez recently sold $300,000 worth of municipal bonds to a Memphis syndicate, using the proceeds of the issue to buy a plant site and to construct buildings for tire manufacture. The negotiations have been carried on between the city of Natchez and the Armstrong Rubber Co. of West Haven, Conn. The plant is to be erected on a 20-acre site adjoining the Illinois Central tracks, with plans to employ at least 600 workers.

It is now learned from reliable sources that the new Natchez plant will be used almost exclusively, for the manufacture of Sears Roebuck tires, through a working arrangement between Sears and Armstrong officials. When Goodyear was making all of Sears tires, Sears Roebuck induced Goodyear to build its present tire plant at Gadsden, Ala.. so that Sears might have a source of manufacture close to its southern markets. At the time Goodyear terminated its Sears contract, Goodyear production of Sears Roebuck tires was averaging nearly 8000 per day.

Calendar of Coming Events

CONVENTIONS AND MEETINGS

SAE Summer Meeting, White Sulphur Springs, W. Va. .....June 12-17
American Society for Testing Materials Meeting, Atlantic City, N. J., June 27-July 1
National Petroleum Association Meeting, Atlantic City, N. J.....Sept. 14-16
SAE National Regional Fuel and Lubricants Meeting, Tulsa, Okla..Oct. 6-7
SAE National Aircraft Production Meeting, Los Angeles, Calif...Oct. 13-15
American Welding Society Meeting, Detroit .....Oct. 17-21
SAE Annual Dinner, New York....Nov. 14
SAE National Transportation Engineering Meeting, Commodore Hotel, New York .....Nov. 14-16
National Safety Council Meeting, Chicago .....Nov. 14-18
American Petroleum Institute Meeting, Chicago .....Nov. 14-18
National Industrial Traffic League Meeting, New York .....Nov. 17-18
SAE National Production Meeting, Nov. 30-Dec. 2
Automotive Service Industries Show, Chicago .....Dec. 5-10
*National Standard Parts Association Meeting, Chicago .....Dec. 2-3

SHOWS

New York, National Motor Truck Show, Nov. 9-15
New York, National Automobile Show, Nov. 11-18
Pittsburgh, Pa., Automobile Show, Nov. 11-18
Detroit, Mich., Automobile Show, Nov. 11-19
Columbus, Ohio, Automobile Show, Nov. 12-18
Buffalo, N. Y., Automobile Show..Nov. 12-19
Chicago, Ill., Automobile Show..Nov. 12-19
Milwaukee, Wis., Automobile Show, Nov. 12-19
Minneapolis, Minn., Automobile Show, Nov. 12-19
*Philadelphia, Pa., Automobile Show, Nov. 12-19
*San Francisco, Calif., Automobile Show .....Nov. 12-19
Los Angeles, Calif., Automobile Show, Nov. 12-20
*Elmira, N. Y., Automobile Show, Nov. 14-19
New Haven, Conn., Automobile Show, Nov. 14-19
Baltimore, Md., Automobile Show, Nov. 19-26
*Washington, D. C., Automobile Show, Nov. 19-26
*Cincinnati, Ohio, Automobile Show, Nov. 20-26
*St. Louis, Mo., Automobile Show, Nov. 20-27
Newark, N. J., Automobile Show, Nov. 26-Dec. 3
Denver, Colo., Automobile Show, Dec. 5-10

*Tentative

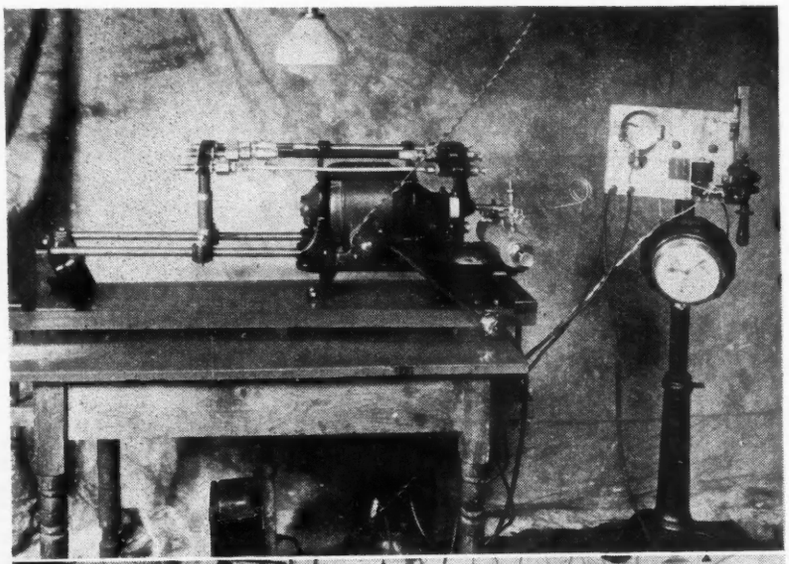
Frank Bellanca May Make Military Aircraft in Canada Plant

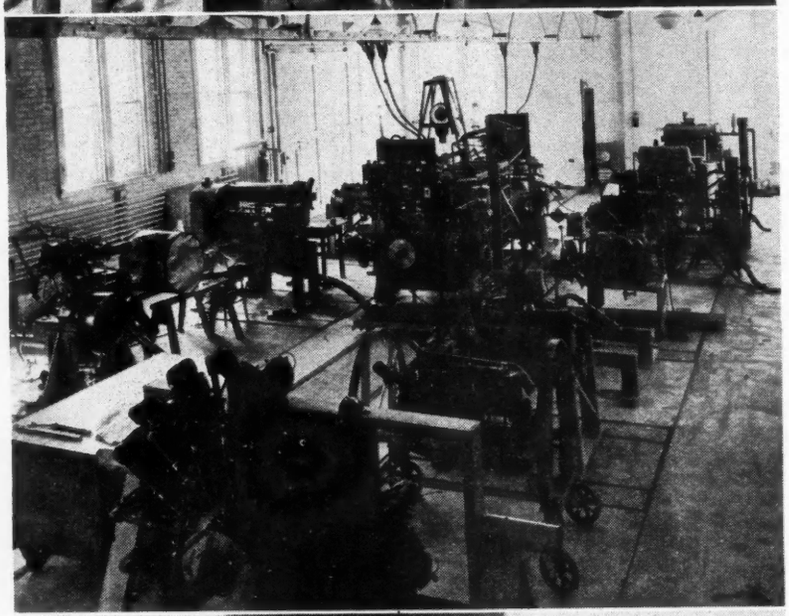
Our correspondent in Canada reports that within four or five months Frank Bellanca, brother of the noted aircraft designer Giuseppe Bellanca, plans to open a plant in Canada to make military planes whose design has already been submitted to the French and British Governments. An office for the Miller-Bellanca Aircraft Corp. was opened in Montreal two months ago.

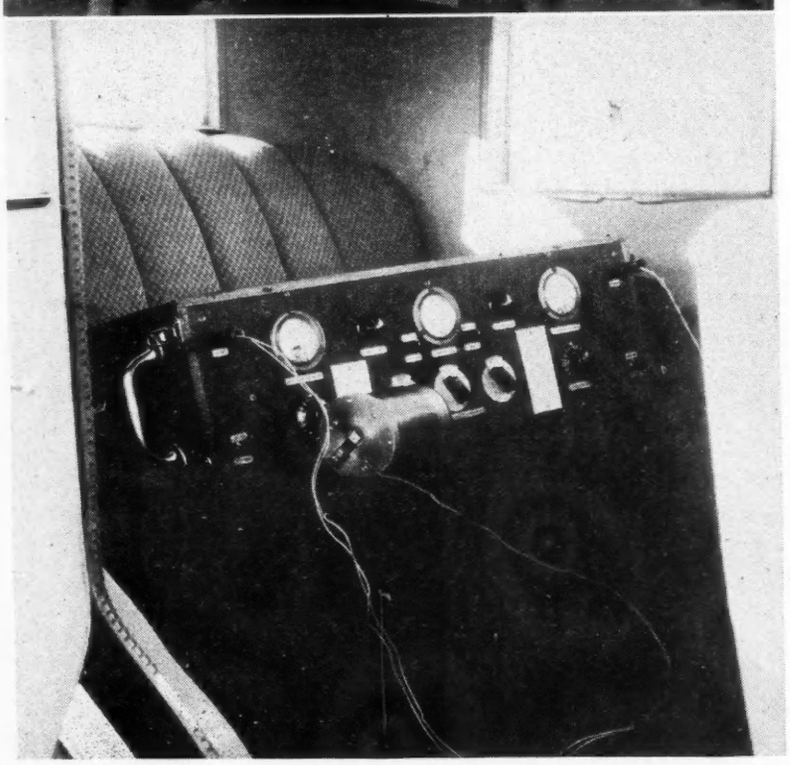
Mr. Bellanca is quoted as follows: "I believe that Canada will become the center of airplane manufacturing . . . because if France and Britain want to buy planes it will be better to build them in Canada than to try and get them in the United States. The situation there is, that United States army and navy authorities cannot give an export release on a military plane until after they have had the exclusive use of it for at least six months. In my experience I have had to wait as long as three years before getting an export release . . ."

Briggs Reports Net Profit Of $9,390,743 for 1937

Annual report of the Briggs Mfg. Co. and its subsidiaries for the year ended Dec. 31, 1937, shows a net profit, after all prior charges, of $9,390,743.







University

By JOSEPH GESCHELIN

WITHIN a short drive from Detroit, the University of Michigan has created a remarkable record of service to the automotive industry in engineering and research.

Among the undergraduate diploma courses that provide the groundwork for automotive engineers, we may class the school of aeronautical engineering which offers the degree of B.Ae.E., and the school of mechanical engineering. The university has excellent facilities in automotive engineering laboratory work which is offered as an option to M.E. students.

Both the aeronautical and mechanical engineering students are required to take certain courses in the Department of Metal Processing to acquire the essentials of machine shop practice, foundry, forge work, and the mechanical arts which are so essential to the background of the designing engineer in any field today. This department is operated under the direction of Dr. O. W. Boston, whose work in metal cutting and cutting fluids research has become classic in industrial circles.

Since space will not permit a detailed examination of the work in all of allied engineering departments, we shall content ourselves with a description of the laboratory facilities, supplemented by comment on some of the most interesting projects.

Research project, studying fatigue properties of compression couplings for gasoline and oil lines. Instrumentation includes an electric clock counter and automatic shut-off in case of failure

Looking down first section of instruction laboratory. Between the two rows of engine beds may be seen the two electric dynamometers on rolling cars with flexible connection to overhead power trolley. Water and exhaust drains lead to two 12 in. steel mains under floor.

One of the many instruments used in road testing of automobiles is the equipment shown here. It is used for measuring sounds in car interiors; also as a means of analyzing frequencies to determine the source of noises.

# of Michigan Automotive Laboratories

are equipped for a wide field of service to the automobile and aircraft industries

Consider first the automotive engineering laboratories under the direction of Prof. Walter E. Lay. Two distinct sections of the main floor are devoted to unique set-ups for engine testing and graduate research work on fuels and engine characteristics. The first of these is laid out with twelve engine beds, served by two electric dynamometers traveling on a track. The second section contains five engine beds served by two electric dynamometers, each of which is mounted on a turntable. This arrangement makes it possible to swing each of the dynamometers into position for driving any of the equipment set up in its vicinity.

The latter section, in addition, has a high speed hydraulic absorption dynamometer which is used for special durability test work. Another interesting piece of equipment is a chassis dynamometer fitted with two six-foot drums. Each of the drums may be selectively driven through a right angle gear drive so located as to facilitate attachment to the turntable dynamometers. The drums can be operated at road speeds up to 70 m.p.h.

The engines found in the laboratory are of modern type with even a few examples of the very latest models as in the case of a 1938 LaSalle engine and the new four-cylinder horizontal Continental air-cooled aircraft engine. The laboratory boasts instrumentation of the very latest type, including recording indicators of various kinds and a cathode ray oscillograph. All instrumentation used for engine testing is mounted on movable stands so as to be readily shifted from one station to another.

One of the special set-ups to be found here is a supercharger testing equipment with all of the necessary instrumentation.

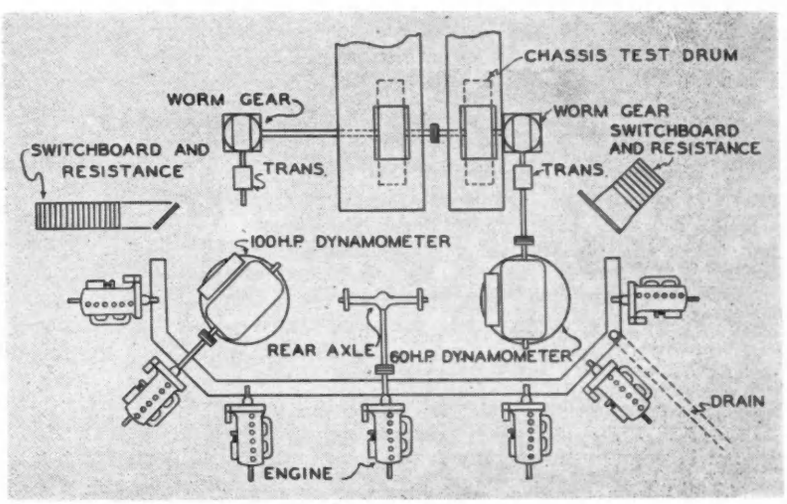
Another important piece of equipment is an N.A.C.A. universal test engine which features variable compression, variable valve timing, variable valve lift, and ready control of cylinder head, cylinder fuel, air, and oil temperatures. It is provided with measuring equipment for many phases of research on internal combustion engines, but has been most used in fuel research, especially for knock rating.

The Engineering Building, a magnificently equipped plant housing the Department of Engineering Research; also the new Physics Building, carry on activities that touch the gamut of automotive problems of design and fabrication. Among the highspots of the facilities of the engineering building are the following few:

A complete section devoted to various phases of highway research, operated in the interest of the Michigan State Highway Department.

The Aeronautical Laboratory includes a large wind tunnel of the open-throat type with double ducts for the recirculation of the air. The tunnel is octagonal in cross-section and the throat diameter may be varied from five to eight feet. With the large diameter, models of fifty-inch span can be tested with air speeds up to ninety miles an hour. The tunnel is equipped for ship- and propeller-model testing. This wind tunnel also is used by the automotive engineering department for special tests such as the effect of streamlining on passenger car bodies, rail cars, etc.

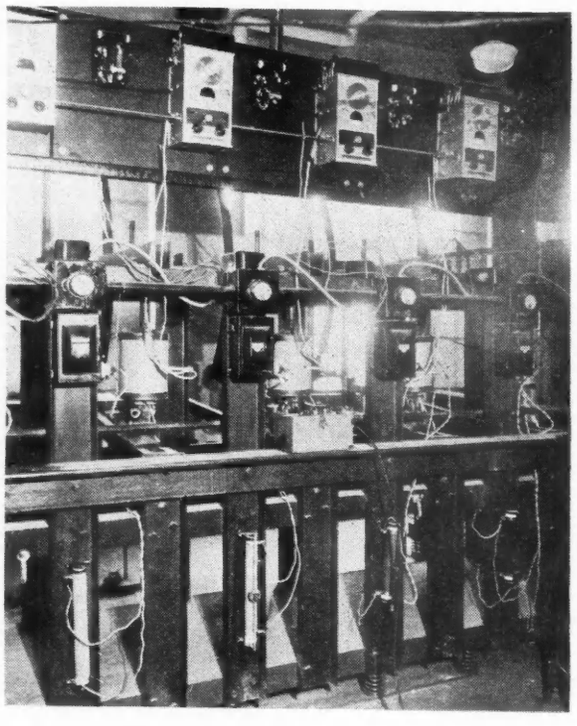
The Gas, Fuel, and Combustion Laboratories constitute a group in the Department of Chemical Engineering in which are housed facilities for conducting research on fuels and their combustion. The gas and fuel general laboratories contain apparatus for the analysis of flue and fuel gases, calorimeters for gas, liquid, and solid fuels, and equipment



Diagrammatic arrangement of swiveling dynamometer stands showing layout of testing equipment including chassis rolls

for testing boiler water, lubricants, and fuels.

The Fuel Research Laboratory for the study of the various factors involved in the utilization of fuel is equipped with the C.F.R. test engine for determining knock ratings of motor fuel according to the new A.S.T.M. procedure, and is connected with an electric dynamometer for determining the effect of compression ratio, air-fuel ratio, and other engine variables which affect the power output and efficiency. This unit may also be used for testing diesel engine fuel by a simple and standardized modification. The laboratory also is supplied with ammonia refrigeration for conducting tests at low temperatures, and with a representative motor for determining ease of starting and acceleration with different fuels and under different conditions. In addition to the standard equipment for making all forms of standard tests on fuels, special fractionating columns are provided for the analysis of liquid and gaseous fuels.



Investigation on creep of metals at elevated temperatures is a long-range research project at the U. of M. Illustration shows portion of one battery of testing machines

The High Temperature Laboratory is one of the best equipped in the country for study of properties of metals at elevated temperatures. It lends itself not only to the study of metals now in production but equally well to the development of new alloys.

The equipment of the pyrometer laboratory includes a wide range of indicating, controlling, and recording instruments, optical and radiation pyrometers, and ample facilities for checking and calibrating pyrometric apparatus.

The X-ray Laboratory has a thoroughly modern equipment including a transformer of capacity up to 280,000 volts for the radiography of metals and another smaller X-ray outfit which is used for researches on crystals with special reference to engineering materials.

The Electro-Chemical Laboratory provides research facilities for electro-chemical work. The laboratories are well equipped for research and development work in electro-plating, and have equipment for the study of electrothermal and high-temperature electrolytic processes.

The Paint and Varnish Laboratory for the study of the manufacture and application of paints, varnishes, nitro-cellulose lacquers, enamels, and other finishing materials contains in addition to regular laboratory facilities, grinding apparatus, washed-air drying kiln, oven for baking japans and varnishes at high temperatures, as well as spray-gun equipment for the application of all kinds of finishing materials.

The Petroleum Laboratories include standard equipment for the recognized tests on petroleum and petroleum products, and in addition much special equipment for special research in petroleum. Some of the more standard equipment available for testing and research includes special fractionating columns for assaying crude oil to determine the yield of different products and the qualities of the products so obtained, and equilibrium vaporization equipment for determining the vaporization characteristics of the crude oils.

The Engineering Shop Laboratories occupy four floors in the south wing of the East Engineering Building. Special care has been taken in the selection and arrangement of equipment to facilitate instructional and research work. A chemical laboratory is provided to aid in the control of foundry operations.

The Machine-Tool Laboratory has been carefully arranged to demonstrate the two types of machine shop methods, tool room and production. One part of the laboratory contains one or more of each of the principal types of machine tools, such as lathes, planers, grinders, shapers, drilling and milling machines, boring mills, and broaching machines, as well as many others of more special types used in tool rooms. In another part of the laboratory the machines are arranged to give a perspective of the machines, tools, and methods used in production. A third part of the laboratory is occupied by a grinding room which contains grinding, polishing, and buffing machines, and auxiliary equipment. Centrally located in the laboratory and under the supervision of an attendant is a well-organized tool crib, containing a comprehensive equipment of measuring instruments, gages, and small tools for machine and hand use. The equipment of the laboratory offers favorable opportunity for research work on the subject of forming and cutting metals.

Among the other facilities of the engineering shop laboratories are—an instrument shop, woodworking laboratory, forging and heat-treating department, and a modern foundry plant.

Much of the research work carried on in the engineering building is of fundamental character for industry, the projects being financed by the interested outside organizations. Some of this work includes long-range projects which may be under way from one to five years. This work is conducted, under the direction of members of the staff, by paid graduate or undergraduate students depending upon the practicalities of the situation.

The Physics Department, too, has devoted considerable attention to special problems arising in the automotive field. One of its major con-

(Turn to page 736, please)

Just Among Ourselves

Fortune Turns to Used Cars . . .

LIKE a raucous symphony, the used car problem surges over the reader of the June issue of *Fortune*. So far as we know, there has never been a better job of dramatizing the principal themes connected with the whole business. On the whole, the facts in the story check with our own body of knowledge, but, naturally there are some distortions due to the requirements of the dramatic art.

Fortune finds: that junking plans which include any sort of bounty to the dealer are really a disguised increase in his gross profit margin, which, since the economics of the situation remains unchanged, he will give away by hiking his apraisals;

that last year, by failing to bring forth any discernible improvements over 1937 models, the automobile factories added in effect another year of economic life to cars on the road;

that the most effective of all junking plans would be another genuine mechanical innovation such as four-wheel brakes or the self-starter.

The last two items hit us with a special impact because, according to a distillation of recent conversations in Detroit, next year's changes in passenger cars are showing a strong tendency to revert to style changes alone. At the beginning of this year there was much talk of the necessity of bringing forth some pretty strong (available) mechanical changes in 1939 cars. Now the talk is swinging away from that position. Part of the blame is being placed on this year's disappointing production to date. Some manufacturers are supposed to be heavily overcommitted on various parts, which will make it necessary to continue using them into next year.

Undoubtedly another cause is unwillingness to risk heavy introduction costs on innovations which are operating on curtailed profits. A majority of the leading original equipment manufacturers are currently operating in the red, and suffer from the same reluctance to risk a great deal on relatively untried new development. But for a few automobile manufacturers this situation will represent the choice between cautiously sinking into the morass or the possibility of rocketing to a safe ledge. It's a tough choice, but we can't help feeling that "the fighting chance" is the more glorious way out.

Diversity Helps Over the Bumps

AS hinted above, 16 out of 26 automotive equipment manufacturers are operating in the red, and look for no real improvement in their operations until the introduction of 1939 motor vehicles. The figure and its corollary appear in the weekly business letter of the Administrative and Research Corporation.

An analysis of the automobile parts and accessories industry by "Poor's Reports" indicates that many parts companies have sought a way out through diversification of production. Forty-three companies whose operations were studied are making among them, besides automotive equipment, agricultural equipment, aircraft, apparel, brewing and distilling equipment, building equipment, electrical equipment, furniture, household utensils, industrial machinery, marine equipment, office equipment, refining machinery, and railroad equipment.

There is every indication that such diversity will continue and broaden. Few equipment manufacturers have managed to earn startling dividends from this policy, but it does seem to have provided a fair cushion against the lowest spots in the depressions.

An Innovation

IN Milwaukee, where a lot of things seem to work that won't work elsewhere in the nation, an A. F. of L. union of retail appliance salesmen has signed a contract with employers in which there is an agreement to help police a code of electrical-appliance trade-in allowances. The code is set out in clear terms, and worked well enough during a 60-day trial period to bring about renewal. Salesmen got closed shop in return for agreement to abide by and police the code. Question of salaries has not yet entered into the agreement, which so far hinges entirely on the question of stabilizing the appliance industry. This is simply reported here because it may turn up in another industry which faces the problem of stabilizing trade-in allowances.

HERBERT HOSKING.

Engine Speed and Load, Oil Characteristics, and Rate of Circulation as Factors . . . .

Determining

By C. G. WILLIAMS
and J. SPIERS*

AS part of a general research on bearings which is now being carried out, it was considered desirable to study the influence of various operating and design factors in regard to bearing temperatures. The technique for measuring the temperature of rotating parts was developed in the institution's laboratories about six years ago and sufficient experience was available with this method to justify its application to an engine. The necessary modifications were carried out on a six-cylinder, 122-cu. in. engine which happened to be available; this engine, while it had seen extensive service in a car, had been recently reconditioned. The results of the preliminary trials were so promising that a fairly extensive program of tests was carried out, the results of which are described here. The experiments, while of considerable interest in themselves, were also of value to the experimenters in indicating improvements in apparatus and technique which could be made in any subsequent application of the method to other engines. In the present tests, the value of the results was limited by the inability of the engine to withstand continuous operation at 3000 r.p.m. or above, and because arrangements had been made to measure the oil feed to the engine as a whole and not to the actual bearings whose temperatures were being measured. Two new engines are now being prepared for further bearing temperature tests, viz., a 4-litre six-cylinder engine with a maximum speed of 3400 r.p.m., and a 1½-litre six-cylinder engine with a maximum speed of 4400 r.p.m. On these engines arrangements are being made to obtain additional temperature measurements and to control and measure certain factors more closely.

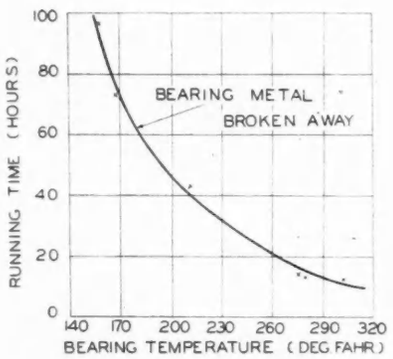


Fig. 1 **Times elapsed before bearing metal broke away occurred at various operating temperatures**

Engine and Test Bed Apparatus

The engine employed for the tests was an overhead-valve type of 2 9/16 in. bore and 4 in. stroke, giving a displacement of 123 cu. in. The crankshaft was of normal design, running in four main bearings. The tin-base white metal of these bearings was carried in detachable brasses, while that of the connecting rod bearings was run directly into the rods. All bearings, both main and big-end, were of the same nominal dimensions, namely 2 in. in diameter and 1.75 in. long.

Lubrication of the engine was normally carried out by a gear pump, submerged in oil in the sump and driven at half engine speed from the center of the camshaft, all oilways being cast or drilled in the metal of the cylinder block and crankcase. For the present tests, the system was modified (see Fig. 2), the engine pump being removed and its driving shaft tunnel and oilways blanked off. A separate pump, driven by a variable-speed D.C. motor, supplied oil from a 3-gal. tank, carried on a scale pan below the front end of the engine sump and fitted with a 1 kw. immersion heater. An adjustable spring-loaded pressure release valve was fitted on the delivery side of the pump, and from the latter oil passed to the engine through a water-tube cooler. Oil entered the engine at the base of a wire-gauze filter mounted on the cylinder block, and from this point its path through the engine was the same as when the engine-driven pump was in operation.

From the filter, oil entered a gal-

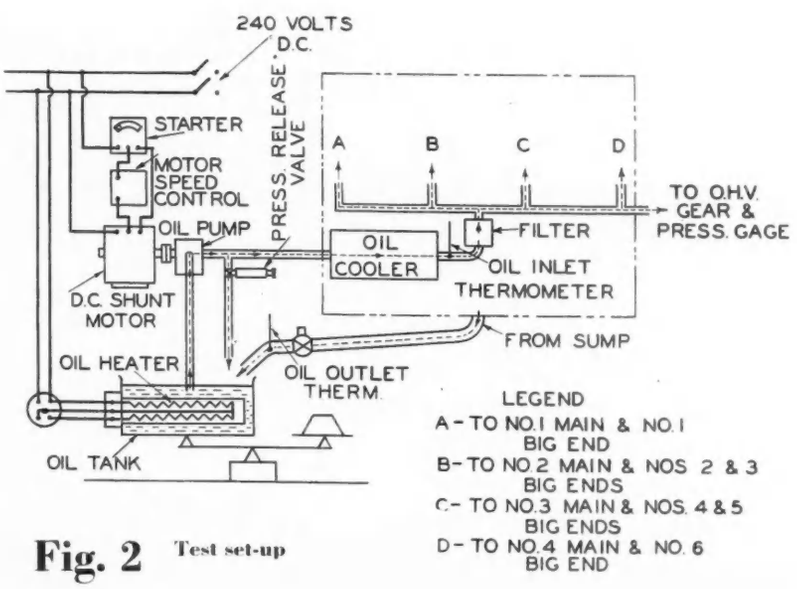


Fig. 2 **Test set-up**

*Released for publication by the Research and Standardization Committee of the Institution of Automobile Engineers.

Bearing-Film Temperature

lery cast in the cylinder block and extending along its side, branch passages from the gallery supplying each main bearing, while a separate pipe carried oil up to the valve gear. The crankshaft was drilled to convey oil from the main bearings to the crankpins, No. 1 big-end bearing being lubricated with oil from No. 1 main bearing, while Nos. 2 and 3 big-ends were both supplied from No. 2 main bearing. Oil drained into the sump, and reached the external tank through a pipe in which a stopcock was included to enable the quantity of oil fed to the engine to be measured. The engine thus worked on the "dry sump" principle, and both the quantity and temperature of the oil supplied could be controlled over a fairly wide range.

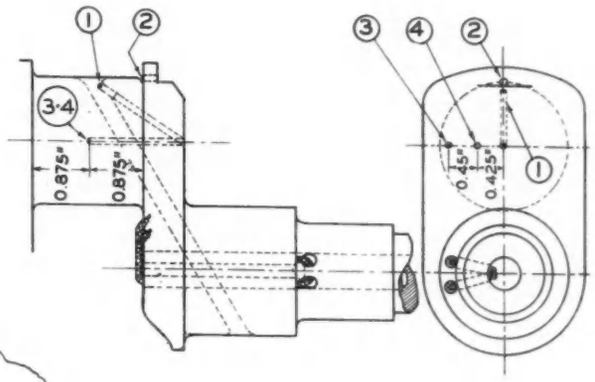


Fig. 4
Crankpin thermocouple positions

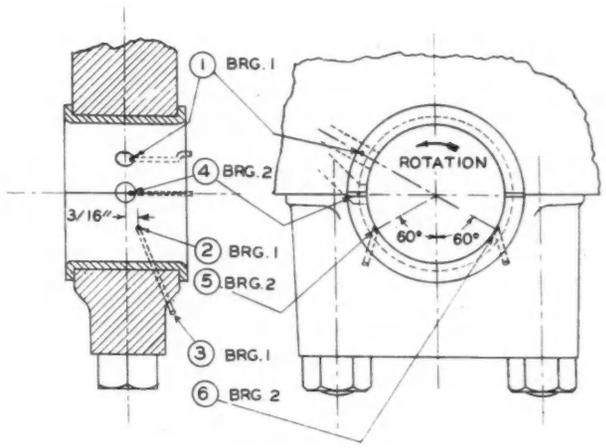


Fig. 3
Thermocouple positions of No.'s 1 and 2 main bearings with oilways and couples

Oil temperatures at the inlet to the engine filter and at the exit from the sump were measured by mercury thermometers.

The engine was coupled to a hydraulic brake and cooled from a water tank, the inlet temperature being maintained at 149 deg. Fahr. (approximately) throughout the tests. Measurements of gasoline consumption were made, and engine and oil pump speeds were obtained with a hand tachometer.

Bearing Temperature Measuring Apparatus

Temperatures of No. 1 crankpin, of Nos. 1 and 2 main bearings, and of the oil supplied to these parts, were obtained by means of thermocouples. These were of copper-constantan, the leads being double-cotton covered wire of 24 s.w.g., while the hot junctions were formed by brazing the two wires together to form beads of approximately 0.060 in. diameter.

Temperatures of the main bearing white metal were measured by soldering the hot junctions into the metal itself (see Fig. 3). Junctions were placed at two points in the cap half of each of Nos. 1 and 2 bearings. The leads were additionally insulated and mechanically protected up to the junction by "Systoflex" tubing, and were brought away through holes drilled in the bearing caps. Couple positions are shown in Fig. 2, couples 2 and 3 being fitted to No. 1 bearing, and couples 5 and 6 to No. 2 bearing.

Couples were also inserted in the oilways to these bearings as near as possible to the point of entry of oil to the bearing. The leads were brought away through holes drilled through the bearing supporting webs into the oilways, the couples being held in position, and oil leakage prevented, by means of wooden wedges. In Fig. 3, couple 1 is the oil inlet couple of No. 1 bearing, and couple 4 that of No. 2 bearing. All the leads from these main bearing couples were held against the crankcase by clips at several points, and brought out through a hole in the side.

Four couples were placed in No. 1 crankpin in positions shown in Fig. 4. Nos. 3 and 4 couples were inserted in holes drilled in the body of the crankpin and were held in position, with the junctions in contact with the crankpin metal, by means of wedges. The junction of No. 1 couple was carried on the head of a fiber plug, and projected into the crankpin oilway near the inlet to the big-end bearing; the plug was a driving fit in the hole drilled to accommodate the couple leads, and prevented oil leakage, as well as insulating the

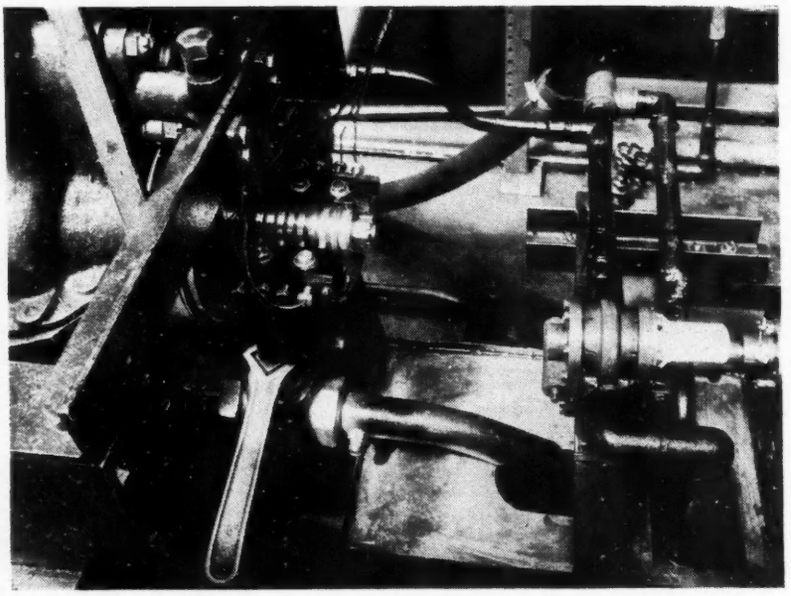


Fig. 5 Each lead was soldered to a slip ring which was mounted on a carrier bolted to the front of the vibration damper

couple wires. No. 2 couple was wedged in a position proud of the crankpin metal, in the corner of the fillet where the oil might be expected to leave the big-end bearing. Readings of this couple were, however, erratic, and no results are quoted in this report.

The leads of all crankpin couples were clipped to the crank web at several points, and taken through the hollow front end of the crankshaft. Each lead was soldered to a slip ring (Fig. 5), of the same metal as the wire, and these rings were mounted on a carrier bolted to the front of the vibration damper. The rings were well insulated from both the carrier and each other, and each lead was individually insulated up to the joint with its ring. Brushes of the same materials as the rings were held in contact with the latter by light springs, and the leads from these brushes, as well as from the main bearing couples, were connected to a double-pole, multi-throw switch, which enabled each couple in turn to be connected to the common cold junction and the measuring instrument.

The latter was a potentiometer, so that true E.M.F.'s were measured, while the cold junction, common to all couples, was formed at the terminals of the instrument, an adjacent mercury thermometer being used in order to correct for variations in cold junction temperature.

Calibration of thermocouples was carried out with the actual potentiometer used during the tests. Hot junctions were immersed in an oil bath, the temperature of which was raised to 300 deg. Fahr. and then allowed to cool, readings of E.M.F.'s being taken with temperatures both rising and falling. Comparative measurements were made with stationary hot junctions and with junctions rotating in the bath and connected to the potentiometer through the slip rings and brushes used in the engine tests. In all cases, provided the slip rings were kept clean and lubricated with oil, the recorded temperatures of both stationary and rotating couples agreed within ±2.7 deg. Fahr. of a common calibration curve, over a range of speeds from 500 to 2000 r.p.m.

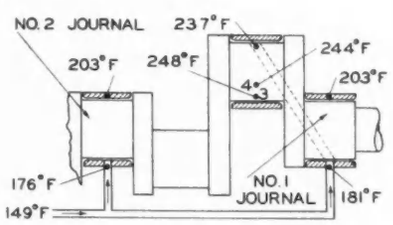


Fig. 6 Engine speed 3000 r.p.m.; oil inlet temperature 149 deg. Fahr.; oil B

Test Results

Fig. 6 illustrates diagrammatically a typical set of readings obtained at an engine speed of 3000 r.p.m. and with an oil inlet temperature of 149 deg. Fahr. to the external oil filter. It will be noted that the oil, in its passage to No. 1 main bearing, was heated to 177 deg. Fahr. through contact with hot walls. The temperature reached by the white metal of the main bearing was 203 deg. Fahr. The portion of the oil supply which entered the oilway in the crankshaft continued to pick up heat from the latter, the temperature reaching 237 deg. Fahr. where the oil entered the big-end bearing. The metal of the crankpin was not much hotter, viz., 248 deg. Fahr. These figures are of interest as indicating that a large proportion of the actual temperature rise of the lubricant may occur, not at the actual bearing surfaces, but in passage-ways through which the oil passes on its way to the bearings; these oilways are surrounded by metal which is conducting heat away from the bearing surfaces where the heat is being generated.

Another feature of interest indicated in Fig. 6 is that the temperature difference between couple 3, which is within ⅛ in. of the surface, and couple 4, which is 9/16 in. from the surface, is only 3.6 deg. Fahr., thereby showing that the temperature gradient in the metal was sufficiently small to justify taking the reading of couple 3 as the surface temperature of the crankpin.

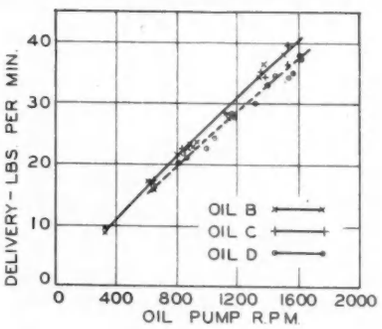


Fig. 7 The rate of oil supply was equivalent to that delivered by the engine pump when driven at half engine speed

Effect of Oil Inlet Temperature

In the following experiments, except where otherwise stated, the rate of oil supply was as given in Fig. 7, being equivalent to that delivered by the engine pump when driven at half engine speed.

Measurements were made of the temperatures recorded by the thermocouples (see Figs. 3 and 4 for their positions) with three lubricants and at various speeds, but with variable oil inlet temperature. It is not proposed to reproduce here all the experimental data, but the results obtained at 3000 r.p.m., being of greater interest than those obtained at lower speeds, are given in

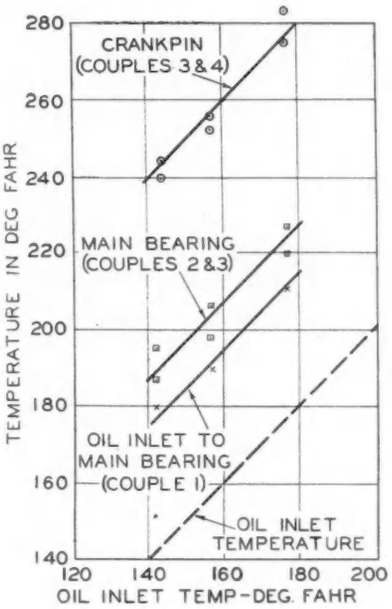


Fig. 8 Engine speed 2976 r.p.m.; oil flow 37.8 lb. per min.; oil B

full in Figs. 8, 9 and 10, the three oils used being denoted by the code letters B, C and D, and their viscosity temperature characteristics given in Fig. 11. Oils B, C and D were supplied by one oil company, and it is understood were derived from the same crude. It is of interest to note that oil D conforms to the S.A.E. "10W" specification for very light oils.

The most striking feature of Figs. 8, 9 and 10 is that the graphs are, as a first approximation, a number of parallel straight lines. Thus, a decrease (or increase) in oil inlet temperature had an approximately equal effect on all the other oil and bearing temperatures measured. As an example, a 10-deg. Fahr. reduction (or increase) in oil inlet temperature resulted approximately in a 10 deg. Fahr. reduction (or increase) in the temperature of the big-end bearing. This is clearly a result of considerable importance, particularly in connection with the efficacy of oil coolers which are used, of course, to control the oil inlet temperature.

The foregoing results, showing the sensitivity of bearing temperature to oil inlet temperature, suggest that

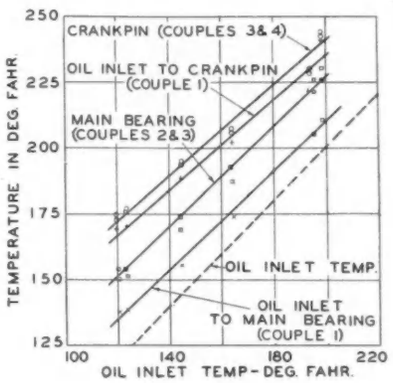


Fig. 10 Engine speed 2940 r.p.m.; oil flow 35.6 lb. per min.; oil D

the lubricant is responsible for the dissipation or evacuation of a large proportion of the heat generated in engine bearings, and it may be opportune, at this stage, to refer briefly to some of the main factors influencing the generation and dissipation of heat in engine bearings, though it should be understood that a more complete treatment and correlation with experimental results must be deferred pending further experiments.

The coefficient of friction in a bearing is a function of ZN/P (Z = operating viscosity of lubricant, N = r.p.m. of journal and P = mean bearing pressure), and it follows that the heat generated is a function of $(ZN/P) \times P \times N$ or, ZN^2, where Z is, of course, a function of temperature. In order to calculate the temperature attained it would be necessary to equate the heat generated to the heat dissipated and, in a bearing, the latter can occur through two main channels, viz., by conduction through metal in contact with the bearing surfaces, and through the rise in temperature of the lubricant. There is probably an intermediate stage whereby some heat is abstracted from the moving parts by the cooling effect of the

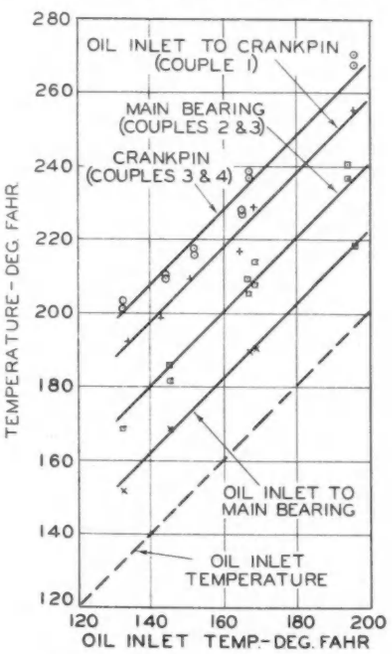


Fig. 9 Engine speed 3004 r.p.m.; oil flow 37.9 lb. per min.; oil C

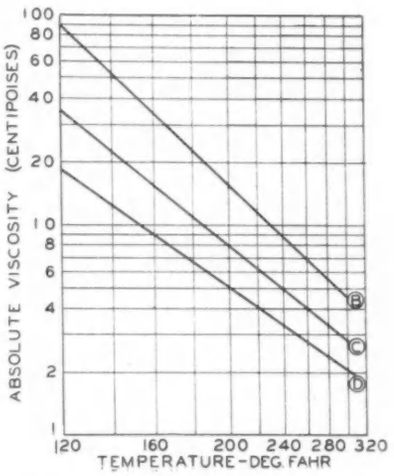


Fig. 11 Viscosity temperature characteristics of three oils

crankcase "atmosphere." In any case, the final dissipation occurs to the external atmosphere from the outside walls of the crankcase, unless an external oil cooler is used.

A satisfactory correlation of experiment with theory, assuming that, as suggested above, the bulk of the cooling is due to the lubricant would, therefore, necessitate a knowledge of the rate of oil flow through the bearing under consideration and the corresponding temperature rise. In the present tests, the total oil supply to the engine was measured and, of this total supply, an unknown proportion reached the main bearing whose temperature was measured while, further, an unknown proportion of the oil supplied to this bearing reached the adjacent big-end. It is clear, therefore, that data are required on the oil flow and temperature increment for individual bearings, and preparation for such experiments is now being made.

Effect of Rate of Oil Circulation

Additional evidence emphasizing the importance of cooling due to the

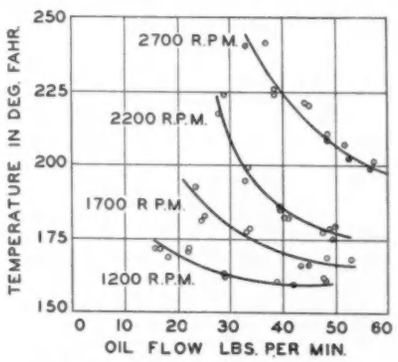


Fig. 12 Oil B; oil inlet temperature 149 deg. Fahr.; B.M.E.P. 40 lb. per in²; crankpin couples 3 and 4

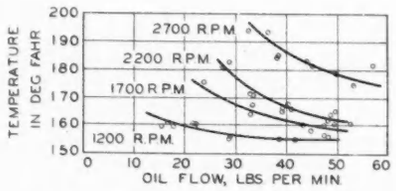


Fig. 13 No. 1 main bearing, showing relation of oil flow and temperature

lubricant is contained in Figs. 12 and 13, which show the effect of rate of oil circulation on the temperature of the crankpin and of the main bearing. It will be noted that the effect is considerable, more especially in regard to the crankpin temperature and at the higher speeds. For example, at 2700 r.p.m. the crankpin temperature was reduced from 241 to 200 deg Fahr. by increasing the oil-flow to the engine from 34 to 58 lb. per min. In fact, the graphs in Fig. 12 suggest that, as a first approximation, the temperature rise was inversely proportional to the rate of oil circulation. This is a

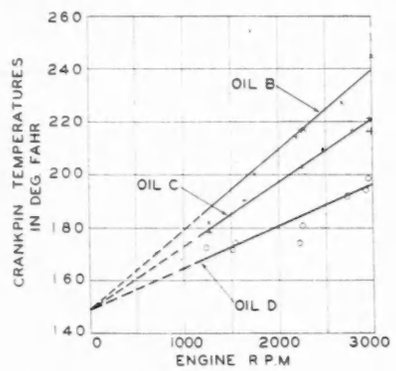


Fig. 14 Crankpin temperatures plotted against engine speed

result of considerable interest, and it follows that, at any one speed, the quantity of heat acquired by the lubricant was approximately constant over a range of oil-flow.

Effect of Engine Speed and Oil Viscosity

From data similar to those recorded in Figs. 8, 9 and 10, and obtained at a number of different speeds, it is possible to plot crankpin and main bearing temperatures against engine speed for the three different lubricants, and this has been done in Figs. 14 and 15.

It will be noted that both crankpin and bearing temperatures increase linearly with engine speed, indicating the importance of this variable. For example, with oil B an increase of speed from 1500 to 3000 r.p.m. resulted in an increase of crankpin temperature from 194 to 239 deg. Fahr., the corresponding main bearing temperatures being 173 and 198 deg. Fahr. Further data at higher speeds will undoubtedly be of interest.

Perhaps the most interesting feature of Figs. 14 and 15 is the important effect of oil viscosity, the lower viscosity oils giving considerably less increase of temperature with speed. For example, the crankpin temperatures with oils B, C and D at 3000

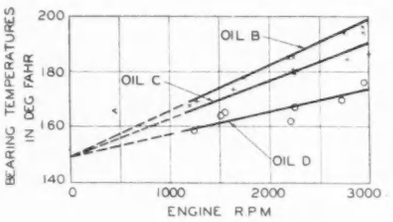


Fig. 15 Bearing temperatures plotted against engine speed

r.p.m. were 239, 221 and 196 degs. Fahr., respectively. Similarly, the graph shows that the same crankpin temperature of approximately 194 deg. Fahr. was reached with the heaviest oil B running at 1500 r.p.m. as with the lightest oil D running at 2900 r.p.m.

The lower temperatures obtained with low-viscosity oils constitutes an important advantage, particularly in regard to bearing life as affected by cracking. In other words, the use of an oil of lower viscosity may actually extend the useful life of a bearing.

Under certain conditions, bearing life may, however, be determined more by the operating viscosity of the lubricant in the bearing, particularly in so far as ordinary wear is concerned, and in Fig. 16 is plotted the actual viscosity of the oil in the crankpin for the three oils B, C and D, corresponding to the data given

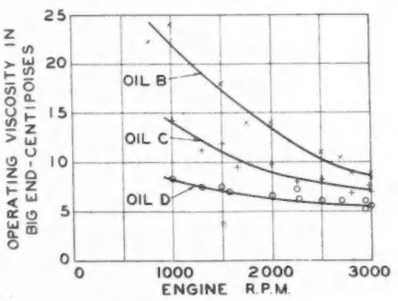


Fig. 16 Viscosity of three oils plotted against engine speed

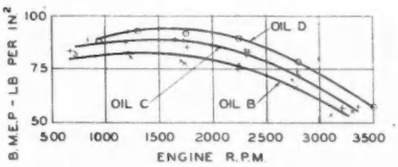


Fig. 17 Effect of lubricating oil on engine B.M.E.P.

in Fig. 14. It is of interest to note that the lighter oils, particularly D, showed comparatively little variation in operating viscosity over quite a wide speed range.

The reduced dissipation of energy in frictional heat is well illustrated in the torque curves obtained with the three oils B, C and D, and plotted in Fig. 17. The maximum B.M.E.P. recorded with the three oils B, C and D was 82.5, 88 and 92.5 lb. per sq. in., respectively. Thus, the engine developed 12.2 per cent more torque with the lightest oil D than with the heaviest oil B.

Effect of Engine Load

It will be recalled that, from theoretical considerations already briefly

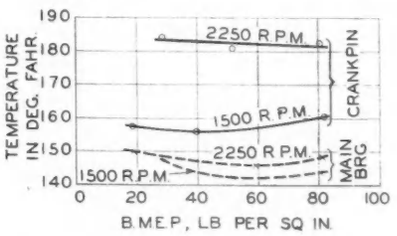
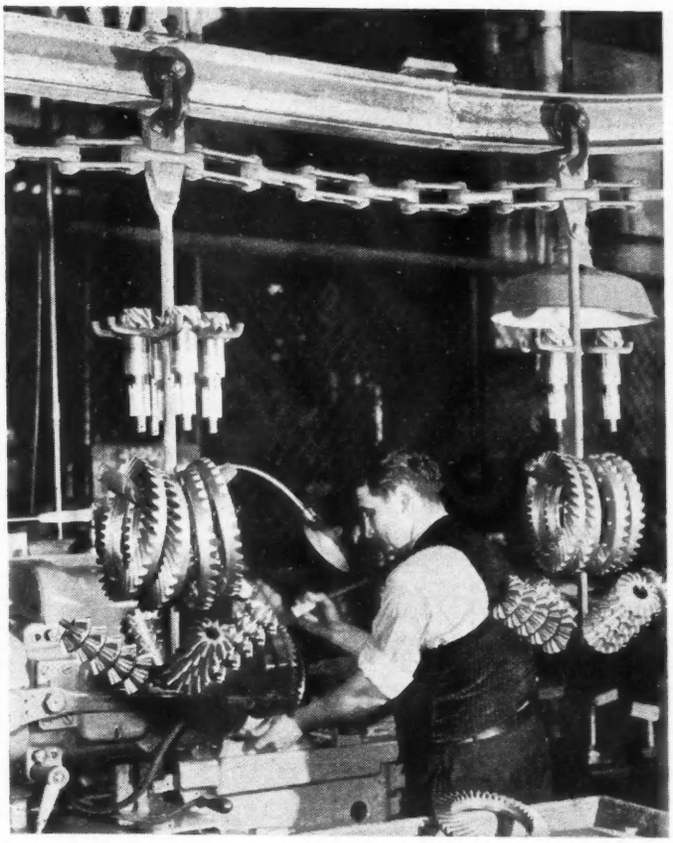


Fig. 18 Bearing temperatures are plotted here against engine load

discussed, the generation of heat in a bearing is a function of ZN^2 and is independent of the bearing pressure P. Experimental results confirming this are given in Fig. 18, in which the crankpin and main bearing temperatures are plotted against brake mean effective pressure: (1) for a speed of 2250 r.p.m. using oil B; (2) for a speed of 1500 r.p.m. using oil D. It will be noted that, over a fairly wide range of engine load, there was comparatively little change in bearing temperature.

It should be observed, however, that in these experiments the oil inlet temperature was maintained constant; if this temperature had been allowed to increase with load through greater heating of the oil from the underside of pistons, cylinder walls, etc., there would have been a corresponding rise in bearing temperature with increase in load.



Overhead conveyor line in the Pontiac axle plant which carries matched sets of drive pinions, ring gears and differential gears to the rear axle assembly line.

Production Lines

Forging Topics

Editorial in current issue of *Drop Forging Topics* stresses the improved machinability of parts produced by modern forging methods. Forging practice has graduated from the blacksmith stage. Chemical and metallurgical laboratories, electrically controlled furnaces, improved die design, modern forging presses—all these and more contribute to the quality of forgings. With modern practice, surface quality, correct flow lines, and freedom from porosity are assured.

New Type

Knottiest problem of welding management has been solved in beautiful fashion by the introduction of a line of standardized welding tips by P. R. Mallory. For a long time there has been no end of confusion due to the multiplicity of tip forms and sizes and what have you. Now, after two years of hard work, the welding people are offered the Mallory line of standardized tips designed to reduce inventories and speed up delivery. That's only part of the story. The welding tools are new in design with sturdy, long-lasting, pointed tips. Moreover, they are produced by a new process with new controls and new equipment. You will find the whole story in a new and handsome, spiral-bound notebook that lists the varieties of new tips, and new line of water-cooled holders, and much useful engineering data. Ask us for your copy of the handbook.

Lube Notes

Current issue (May, 1938), of *Lubrication*, Texas Co. technical publication, contains timely discussion of motor coach lubrication problems. What it has to say about motor coaches applies equally as well to the lubrication of motor trucks. Although most of the discussion centers about the lubrication of high speed, heavy duty engines, there is a lot of meat in the brief section devoted to the lubrication of axles and transmissions. If you don't get *Lubrication* regularly you are missing something.

Coolant or Lube

Chemist for one of the largest car builders talked to us the other day about the onerous tax on cutting fluids. As we all know there has been a tax on cutting oils for a long time, on the theory that an oil is an oil and it lubricates, even if it's a hair oil. Actually the tax is unjustifiable in many respects. Take emulsions for example. It is invariably true that the sole function of an emulsion in metal cutting is to serve as a coolant, not a lubricant. In fact, there are but few examples where the cutting fluid is required to behave as a lubricant. The pressure of the chip on the top of the cutting tool is so great that a lubricating film couldn't exist, even if it were needed. On heavy cutting jobs, the cutting fluid serves as an E-P material by virtue of its anti-weld properties, and in this case there would have to be a redefinition of the term "lubricant," if one were to decide whether the cutting fluid is a lubricant under the Excise Act, or whether it is something else.

Diesel Pump

Old-line parts maker has had a Diesel fuel pump and injector in the works so long that we had completely forgotten about it. Just learned, however, that the unit has been pretty much alive and is about ready for disclosure. The sales manager, usually a conservative, seems so enthusiastic that we commend the unit for careful consideration.

Many Washers

A noteworthy feature of one of the big tractor plants we visited recently is the practice of washing everything that should be washed, using the well-known Niagara automatic washer. We doubt whether any plant the size of the one we have in mind can boast so many washing machines.—J. G.

American Automotive Diesel and Other Heavy Oil Engines

MAKE AND MODEL	Designed for	Type	Number of Cylinders Bore and Stroke	Piston Displacement (Cu. In.)	Maximum Intermittant Hp. at Specified R.P.M.	Maximum Continuous Hp. at Specified R.P.M.	Compression Ratio—To 1	Cycle	Compression Pressure at Specified R.P.M.	Maximum Pressure (Lbs. per Sq. In.)	B.M.E.P. at Continuous Hp. (Lbs. per Sq. In.)	Weight per Continuous Hp. (Lbs.)	Maximum Torque in Lbs. Ft. at Specified R.P.M.	Weight Equipped (Lbs.)	VALVES: Arrangement	Intake Port Diam. and Lift	Exhaust Port Diam. and Lift.	Timing (Degrees): Inlet Opens	Inlet Closes	Exhaust Opens	Exhaust Closes	PISTONS: Material	Length	No. of Rings per Piston	Weight with Rings and Pin (Lbs.)	CONNECTING RODS: Material	Center to Center Length	Weight with Cap and Bushings	INJECTION VALVE: Valve Type, Open or Closed	Type Orifices Single, Multiple or Pintle	Injection Pressure (Lbs. per Sq. In.)	Fuel Consumption at Rated Load (Lbs. per B. Hp. Hr.)	Starting Method
Allis-Chalmers SO		Tr	DI* 4-5 3/4x6 1/2	675.0		83-1050	6.5	4	155-500	450	93	30.7	440-750	2550	VI	2.25-.490	2.00-.490	TC	45AB	49BB	19A	ECI	8.50	4	12.0	1045	13.0	12.0	C	Mul	1300	.50	H,E
Allis-Chalmers KO		Tr	DI* 4-5 1/4x6 1/2	563.0		74-1050	6.5	4	155-500	450	99	29.5	370-750	2180	VI	2.25-.500	1.87-.500	5A	14OB	136A	9A	ECI	8.18	4	11.10	1045	13.0	11.0	C	Mul	1300	.49	H,E
Allis-Chalmers LO		Tr	DI* 6-5 1/4x6 1/2	844.0		111-1050	6.5	4	150-500	450	99	29.5	560-750	3275	VI	2.25-.500	1.87-.500	5A	14OB	136A	9A	ECI	8.18	4	11.10	1045	13.0	11.0	C	Mul	1300	.48	H,E
Atlas Imperial 2AM115		M	DI 2-4 3/4x6 1/2	230.0		18-950	15.0	4	520-950	675	65	83.3		1500	VI	1.62-.390	1.50-.468	5B	35AB	40BB	TC	CI	8.25	6	11.50	1040	13.0	10.8	C	Mul	3500	.43	Ele
Atlas Imperial 4AM115		M	DI 4-4 3/4x6 1/2	460.0		40-950	15.0	4	520-950	675	72	59.5		2380	VI	1.62-.390	1.50-.468	5B	35AB	40BB	TC	CI	8.25	6	11.50	1040	13.0	10.8	C	Mul	3500	.41	Ele
Buda 4DT-196		C,T,TrR	AC 4-3 5/8x4 3/4	195.3	43-2000	35-1800	14.0	4	390-600	725	79	25.7	143-1400	900	VI	1.37-.486	1.18-.486	20B	38AB	135A	167BB	Ala	4.93	5	3.0	1035	9.50	3.41	C	Pin	2000	...	Ele
Buda 4DTM-196		M	AC 4-3 5/8x4 3/4	195.3	50-2400	42-1800	14.0	4	390-600	725	95	23.8	125-1400	1000	VI	1.37-.486	1.18-.486	20B	38AB	135A	167BB	Ala	4.93	5	3.0	1035	9.50	3.41	C	Pin	2000	...	Ele
Buda 4LD-1161		R	AC 4-6 1/2x8 3/4	1161.0	133-1100	112-1000	12.0	4	370-600	625	75	...	815-600	...	VI	2.37-.686	2.12-.687	20B	35AB	140A	165BB	Al	9.31	6	17.50	1035	17.75	27.0	C	Pin	1600	.46	Ele
Buda 6LD-275		C,T,Tr,B	AC 6-3 1/2x4 3/4	274.2	69-2400	52-1800	13.5	4	...	625	84	22.9	200-1200	1190	VI	1.37-.486	1.12-.486	20B	38AB	135A	167BB	Al	4.93	5	2.85	1035	9.50	3.41	C	Pin	2000	...	Ele
Buda 6LDM-275		M	AC 6-3 1/2x4 3/4	274.2	70-2400	58-1800	13.5	4	370-600	625	93	20.5	180-1300	1190	VI	1.37-.486	1.12-.486	20B	38AB	135A	167BB	Al	4.93	5	2.85	1035	9.50	3.41	C	Pin	2000	.48	Ele
Buda 6DT-315		C,T,Tr,B	AC 6-3 3/8x4 3/4	314.8	79-2400	60-	14.4	4	390-600	725	...	19.8	230-1200	1190	VI	1.37-.486	1.18-.486	20B	38AB	135A	167BB	Ala	4.93	5	3.50	1035	9.50	3.41	C	Pin	2000	...	Ele
Buda 6LD-415		T,Tr,B	AC 6-4x5 1/2	415.0	75-1800	61-1600	13.3	4	370-600	625	73	23.2	308-1100	1415	VI	1.46-.476	1.37-.476	12B	36AB	145A	174BB	Al	5.25	5	4.01	6140	11.0	4.87	C	Pin	2000	.47	Ele
Buda 6LDM-415		M	AC 6-4x5 1/2	415.0	95-2000	89-1800	13.3	4	370-600	625	94	17.9	280-1100	1590	VI	1.46-.476	1.37-.476	12B	36AB	145A	174BB	Al	5.25	5	4.01	6140	11.0	4.87	C	Pin	2000	.47	Ele
Buda 6LD-468		T,Tr,B	AC 6-4 1/4x5 1/2	468.0	85-1800	69-1600	13.0	4	370-600	625	73	20.8	350-1100	1435	VI	1.59-.476	1.37-.476	12B	36AB	145A	174BB	Al	5.25	5	4.65	6140	11.0	4.87	C	Pin	2000	.47	Ele
Buda 6LDM-468		M	AC 6-4 1/4x5 1/2	468.0	110-2000	103-1800	13.0	4	370-600	625	97	15.6	316-1100	1610	VI	1.59-.476	1.37-.476	12B	36AB	145A	174BB	Al	5.25	5	4.65	6140	11.0	4.87	C	Pin	2000	.47	Ele
Buda 6LD-638		T,Tr,B,R	AC 6-4 3/4x6	638.0	110-1700	76-1200	12.5	4	370-600	625	79	31.2	464-1100	2360	VI	1.75-.516	1.56-.516	15B	35AB	140A	170BB	Al	6.00	5	5.43	6140	12.50	10.25	C	Pin	2000	...	Ele
Buda 6LDM-638		M	AC 6-4 3/4x6	638.0	125-1700	115-1500	12.5	4	370-600	625	95	22.6	460-1100	2600	VI	1.75-.516	1.56-.516	15B	35AB	140A	170BB	Al	6.00	5	5.43	6140	12.50	10.25	C	Pin	2000	...	Ele
Buda 6LD-691		T,Tr,B	AC 6-4 3/4x6 1/2	691.0	120-1700	83-1200	12.5	4	370-600	625	79	31.3	504-1100	2600	VI	1.75-.516	1.56-.516	15B	35AB	140A	170BB	Al	6.00	5	5.43	6140	12.50	10.25	C	Pin	2000	...	Ele
Buda 6LDM-691		M	AC 6-4 3/4x6 1/2	691.0	135-1700	124-1500	12.5	4	370-600	625	95	21.0	450-1100	2600	VI	1.75-.516	1.56-.516	15B	35AB	140A	170BB	Ala	6.00	5	5.43	6140	12.50	10.25	C	Pin	2000	...	Ele
Buda 6LD-909		T,Tr,B,R	AC 6-5 1/4x7	909.0	138-1500	129-1500	12.2	4	370-600	625	75	23.3	700-900	3010	VI	1.90-.540	1.78-.540	17B	33AB	141A	169BB	Al	6.50	5	9.30	6140	14.25	13.10	C	Pin	1500	.46	Ele
Buda 6LDM-909		M	AC 6-5 1/4x7	909.0		152-1500	12.2	4	370-600	625	88	22.4	595-900	3400	VI	1.90-.540	1.78-.540	17B	33AB	141A	179BB	Al	6.50	5	9.30	6140	14.25	13.10	C	Pin	1500	.47	Ele
Buda 6LD-1611		Tr,R	AC 6-6 1/4x8 3/4	1611.0	175-1100	146-1000	12.0	4	370-600	625	72	41.4	1130-600	6050	VI	2.37-.687	2.12-.687	20B	35AB	150A	165BB	Al	9.31	5	15.75	1035	17.75	27.0	C	Pin	1600	.47	Ele
Buda 6LDM-1742		M	AC 6-6 1/2x8 3/4	1742.0	200-1100	200-1100	12.0	4	370-600	625	83	33.0	1220-600	6600	VI	2.37-.687	2.12-.687	20B	35AB	140A	165BB	Al	9.31	5	17.50	1035	17.75	27.0	C	Pin	1600	.49	Ele
Buda 6LD-1742		R	AC 6-6 1/2x8 3/4	1742.0	194-1100	160-1000	12.0	4	370-600	625	73	38.1	1220-600	6100	VI	2.37-.687	2.12-.687	20B	35AB	140A	165BB	Al	9.31	5	17.50	1035	17.75	27.0	C	Pin	1600	.47	Ele
Caterpillar D4400		Tr,R	PC 4-4 1/4x5 1/2	312.0	44-1400	33-1400	16.0	4	625-1400	840	60	59.8	180-900	1975	VI	1.50-.375	1.50-.375	12B	30AB	130A	158BB	Ala	6.12	6	5.25	1040	10.25	8.50	O	Sin	1550	.46	G
Caterpillar D6600		Tr,R	PC 3-5 3/4x8	623.0	60-850	45-850	15.5	4	595-850	830	67	72.4	396-650	3260	VI	2.06-.468	2.06-.468	12B	30AB	130A	158BB	Ala	9.18	6	14.0	1040	15.0	19.0	O	Sin	1500	.45	G
Caterpillar D7700		Tr,R	PC 4-5 1/4x8	693.0	66-850	50-850	15.5	4	595-850	830	67	80.6	426-700	4030	VI	2.06-.468	2.06-.468	12B	30AB	130A	158BB	Ala	9.18	6	8.69	1040	15.0	19.0	O	Sin	1550	.45	G
Caterpillar D8800		Tr,R	PC 4-5 3/4x8	831.0	80-850	60-850	15.5	4	595-850	830	67	68.2	513-700	4090	VI	2.06-.468	2.06-.468	12B	30AB	130A	158BB	Ala	9.18	6	14.0	1040	15.0	19.0	O	Sin	1550	.43	G
Caterpillar D11000		Tr,R	PC 6-5 1/4x8	1039.0	100-850	75-850	15.5	4	595-850	830	67	65.9	645-650	4945	VI	2.06-.468	2.06-.468	12B	30AB	130A	158BB	Ala	9.18	6	14.0	1040	15.0	19.0	O	Sin	1550	.44	G
Caterpillar D13000		Tr,R	PC 6-5 3/4x8	1246.0	125-850	95-850	15.5	4	595-850	830	71	53.0	824-650	5035	VI	2.06-.468	2.06-.468	12B	30AB	130A	158BB	Ala	9.18	6	14.0	1040	15.0	19.0	O	Sin	1550	.44	G
Caterpillar D17000		Tr,R	PC 8-5 3/4x8	1662.0	160-850	120-850	15.5	4	595-850	830	67	63.3	1020-650	7600	VI	2.06-.468	2.06-.468	12B	30AB	130A	158BB	Ala	9.18	6	14.0	1040	15.0	19.0	O	Sin	1550	.43	G
Cooper-Bessemer GN8		SL	DI 8-10 1/2x13 1/2	7260.0		750-750	...	4	...	...	109	36.0	7250-425	27000	VI	...	...	20B	35AB	35BB	20A	Al	17.25	7	56.0	3140	27.0	...	C	Mul	7500	.38	A,E
Cooper-Bessemer GN6		SL	DI 6-10 1/2x13 1/2	5450.0		550-750	...	4	400-375	700	107	38.1	5430-425	21000	VI	...	...	20B	35AB	35BB	20A	Al	17.25	7	56.0	3140	27.0	...	C	Mul	7500	.38	A,E
Cooper-Bessemer EN8		SL	DI 8-8x10 1/2	4220.0		400-900	...	4	400-450	750	83	28.7	3270-550	11500	VI	...	...	20B	35AB	35BB	20A	Al	13.75	6	29.0	3140	21.0	...	C	Mul	7500	.38	A,E
Cooper-Bessemer EN6		SL	DI 6-8x10 1/2	3160.0		300-900	...	4	400-450	750	83	30.0	2450-550	9000	VI	...	...	20B	35AB	35BB	20A	Al	13.75	6	29.0	3140	21.0	...	C	Mul	7500	.38	A,E
Cummins HB-400		T,Tr,B,M,R	DI 4-4 7/8x6	448.0	85-1800	55-1200	17.0	4	500-(a)	750	81	29.8	290-1800	1640	VI	1.93-.378	1.93-.378	6A	46AB	50A	14A	CI	6.25	4	10.20	4130	12.0	10.0	C	Mul	4000	.45	Ele
Cummins HB-600		T,Tr,B,M,R	DI 6-4 7/8x6	672.0	150-1800	100-1200	17.0	4	500-(a)	750	98	21.2	430-1800	2120	VI	1.93-.378	1.93-.378	6A	46AB	50A	14A	CI	6.25	4	10.20	4130	12.0	10.0	C	Mul	4000	.45	Ele
De LaVergne VE		R	TC 6-9x12	4570.0		400-850	14.9	4	475-500	650	81	20.0	2750-500	8000	VI	3.50-.906	3.50-.906	30B	30AB	130A	170BB	Ala	13.0	7	45.0	4140	24.0	64.0	C	Mul	3500	.42	A
De LaVergne VE		R	TC 8-9x12	6220.0		520-850	14.9	4	475-500	650	78	19.2	3700-500	10000	VI	3.50-.906	3.50-.906	30B	30AB	130A	170BB	Ala	13.0	7	45.0	4140	24.0	64.0	C	Mul	3500	.42	A
De LaVergne VL		R	TC 8-7x8	2470.0		280-1200	15.8	4	500-600	700	75	20.7	1500-600	5800	VI	2.75-.656	2.75-.656	20B	20AB	130A	170BB	Ala	10.43	6	22.0	4140	16.0	28.0	C	Mul	3500	.44	A,E
De LaVergne VL		R	TC 6-7x8	1850.0		210-1200	15.8	4	500-600	700	75	21.4	1125-600	4500	VI	2.75-.656	2.75-.656	20B	20AB	130A	170BB	Ala	10.43	6	22.0	4140	16.0	28.0	C	Mul	3500	.44	A,E
Fairbanks-Morse (1) 36A4-1/4		M,R	TC 6-4 1/4x6	510.7	75-1200	60-1200	16.8	4	560-1200	750	77	...	330-1050	...	VI															C	Pin	1700	.48	G,E
Fairbanks-Morse (2) 36A5-1/2		M,R	TC 8-5 1/2x7 1/2	1426.0	266-1100	120-900	14.8	4	475-900	750	74	...	872-900	...	VI															C	Pin	1700	.48	A,E,G
Fairbanks-Morse (3) 36A8		M,R	DI 6-8x10 1/2	3167.0	260-720	210-720	14.9	4	485-720	800	73	...	1920-600	...	VI															C	Mul	3000	....	A
Hall-Scott 140		T,B	.... 6-5x6	706.8		133-1800	14.9	4	430-1000	925	83	16.4	420-1200	2180	VI	2.31-.421	1.75-.421	5B	60AB	55BB	10A	Ala	8.25	6	10.89	4140	11.0	9.22	C	Pin	1500	.45	Ele
Hall-Scott 142		M	.... 6-5x6	706.8		140-1800	14.9	4	430-1000	925	87	23.8	...	3330	VI	2.31-.421	1.75-.421	5B	60AB	55BB	10A	Ala	8.25	6	10.89	4140	11.0	9.22	C	Pin	1500	.45	Ele
Hercules DOOB		M,T,Tr,B,R	TC 4-3 3/8x4 1/2	199.0	62-2600	48-1800	16.0	4	490-1000	760	106	17.7	142-1500	850	VI	1.62-.375	1.12-.375	12B	44AB	44BB	12A	Ala	4.84	6	3.55	CNM	8.0	4.90	C	Pin	1650	.52	H,E
Hercules DOOC		M,T,Tr,B,R	TC 4-4x4 1/2	226.2	70-2600	55-1800	16.0	4	500-1000	770	107	16.2	161-1500	890	VI	1.62-.375	1.12-.375	12B	44AB	44BB	12A	Ala	4.84	6	3.85	CNM	8.0	4.90	C	Pin	1650	.52	H,E
Hercules DOOD		M,Tr,R	TC 4-4 1/4x4 1/2	255.0	56-1600	56-1600	16.0	4	500-1000	770	109	16.6	181-1500	930	VI	1.62-.375	1.12-.375	12B	44AB	44BB	12A	Ala	4.84	6	4.10	CNM	8.0	4.90	C	Pin	1650	.44	H,E
Hercules DJXB		M,T,Tr,B,R	TC 6-3 1/2x4 1/2	260.0	77-2600	60-1800	15.0	4	475-1000	750	102	16.3	178-1500	980	VI	1.62-.375	1.12-.375	12B	44AB	44BB	12A	Ala	4.84	6	3.25	CNM	8.0	4.90	C	Pin	1650	.48	H,E
Hercules DJXC		M,T,Tr,B,R	TC 6-3 3/4x4 1/2	298.0	83-2600	69-1800	15.0	4	475-1000	750	102	14.8	208-1500	1020	VI	1.62-.375	1.12-.375	12B	44AB	44BB	12A	Ala	4.84	6	3.55	CNM	8.0	4.90	C	Pin	1650	.48	H,E
Hercules DRXB		M,T,Tr,B,R	TC 6-4 3/4x5 1/4	474.0	120-2000	104-1600	15.0	4	475-1000	750	109	17.1	350-1300	1780	VI	2.00-.395	1.37-.395	12B	44AB	44BB	12A	Ala	6.84	6	7.10	CNM	9.37	9.20	C	Pin	1650	.46	G,E
Hercules DRXC		M,Tr,R,Ind	TC 6-4 3/4x5 1/4	529.0	103-1400	103-1400	15.0	4	475-1000	750	110	17.7	388-1300	1820	VI	2.00-.395	1.37-.395	12B	44AB	44BB	12A	Ala	6.84	6	7.50	CNM	9.37	9.20	C	Pin	1650	.42	G,E
Hercules DHXB		M,T,Tr,B,R	TC 6-5x6	707.0	160-1600	142-1400	15.0	4	475-1000	750	114	17.7	530-1400	2520	VI	2.37-.500	1.62-.500	5B	50AB	45BB	10A	Ala	7.53	6	9.53	CNM	12.0	11.70	C	Pin	1650	.44	G,E
Hercules DHXC		M,Tr,R	TC 6 5 1/2x6	855.0	127-1000	127-1000	15.0	4	475-1000	750	118	20.1	675-875	2550	VI	2.37-.500	1.62-.500	5B	50AB	45BB	10A	Ala	7.53	6	10.0	CNM	12.0	11.70	C	Pin	1650	.45	G,E

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AUTOMOTIVE DIESEL AND OTHER HEAVY OIL ENGINES

MAKE AND MODEL	GENERAL: Designed for	Type	Number of Cylinders Bore and Stroke (In.)	Piston Displacement (Cu. In.)	Rated Brake Hp. at Specified R.P.M.	Compression Ratio—to 1	Cycle	Compression Pressure at Specified R.P.M.	Maximum Pressure (Lb. per Sq. In.)	B.M.E.P. at Rated Hp. (Lb. per Sq. In.)	Weight per Rated Brake Hp. (Lb.)	Maximum Torque in Lb. Ft. at Specified R.P.M.	Weight Equipped (Lb.)	VALVES: Arrangement	Intake Port Diameter and Lift (In.)	Exhaust Port Diameter and Lift (In.)	Timing (Degrees): Inlet Opens	Inlet Closes	Exhaust Opens	Exhaust Closes	PISTONS: Material	Length (In.)	No. of Rings per Piston	Weight with Rings and Pin (Lb.)	CONNECTING RODS: Material	Center to Center Length (In.)	Weight with Cap and Bushings (Lb.)	INJECTION VALVE: Valve Type, Open or Closed	Type Orifices Single, Multiple or Pintle	Injection Pressure (Lb. per Sq. In.)	Fuel Consumption at Rated Load (Lb. per B. Hp. Hr.)	Starting Method
BRITISH																																	
A. E. C.	T,B	TC	6-4.13x5.74	462.3	115-2400	16.5	4	500-1000	700	82	10.3	330-1300	1186	VI	1.73-.484	1.49-.484	10B	38AB	140A	172BB	Ala	5.90	7	4.50	CN	10.70	6.0	O	Pin	1543	.40	Ele
A. E. C.	M,T,B,R	TC	6-4.52x5.59	539.8	130-2400	16.5	4	500-1000	700	79	11.4	360-1250	1480	VI	1.88-.484	1.61-.484	10B	38AB	140A	172BB	Ala	5.82	6	5.09	CN	11.41	7.12	O	Pin	1543	.40	Ele
A. E. C.	M,T,B	TC	4-4.72x5.74	403.8	85-2000	16.5	4	500-1000	700	83	13.8	275-1200	1170	VI	1.65-.448	1.49-.448	10B	38AB	140A	172BB	Ala	6.29	5	5.82	CN	10.70	8.50	O	Pin	1543	.40	Ele
Brooke 12/16	M,Tr,R	DI	2-4x4¾	120.0	32-1400	18.0	4	450-1000	750	151	21.2	92-1000	680	VI	1.37-.312	1.37-.312	TC	43AB	140A	TC	CI	5.15	5	3.50	Stl	10.25	5.75	C	Pin	1500	.45	Ele
Brotherhood (5) R25	M,R	DI	6-5⅛x8½	1126.5	150-1275	....	4	.....	800	83	34.3	.....	5150	SS	.....	.....	.....	.....	.....	.....	CI	.....	6	.....	NS	18.50	.....	.....	Sin	1500	.40	Air
Crossley V.R.6	T,Tr,B	PC	6-4¼x5½	510.0	100-1700	17.8	4	600-1000	800	91	15.1	320-1000	1512	VI	1.75-.500	1.50-.500	5B	41AB	130A	168BB	Ala	6.06	7	5.12	2340	13.25	9.50	C	Pin	1500	.42	Ele
Dorman 6DL	Tr,R	DI	6-4.72x7.08	744.8	128-1500	14.0	4	450-1000	950	91	21.0	508-1000	2690	VI	1.87-.621	1.75-.621	10B	44AB	44BB	10A	Ala	6.75	6	.....	S76	14.25	.....	C	Mul	2300	.37	Ele
Dorman 4DL	Tr,R	DI	4-4.72x7.08	496.5	86-1500	14.0	4	450-1000	950	91	21.5	340-1000	1846	VI	1.87-.621	1.75-.621	10B	44AB	44BB	10A	Ala	6.75	6	.....	S76	14.25	.....	C	Mul	2300	.37	H,E
Dorman 4JUR	T,B	TC	4-4.00x5.11	257.1	58-2000	17.5	4	575-1000	850	89	21.2	166-1200	1230	VI	1.50-.433	1.37-.381	7½B	37½AB	42½BB	7½A	Ala	5.00	5	3.52	S76	10.50	6.61	C	Pin	1470	.40	H,E
Dorman 6JUR	T,B	TC	6-4.00x5.11	385.7	90-2400	17.5	4	575-1000	850	77	14.9	240-1400	1340	VI	1.50-.433	1.37-.381	7½B	37½AB	42½BB	7½A	Ala	5.00	5	3.52	S76	10.50	6.61	C	Pin	1470	.40	Ele
Dorman 4HW	T,B	TC	4-4.52x5.11	329.5	72-2000	16.5	4	550-1000	850	87	15.5	210-1200	1115	VI	1.87-.526	1.62-.446	7½B	37½AB	42½BB	7½A	Ala	6.00	5	4.87	S76	10.50	8.65	C	Pin	1470	.40	Ele
Dorman 6HW	T,B	TC	6-4.52x5.11	494.2	112-2000	16.5	4	550-1000	850	90	16.9	330-1400	1900	VI	1.87-.526	1.62-.446	7½B	37½AB	42½BB	7½A	Ala	6.00	5	4.87	S76	10.50	8.65	C	Pin	1470	.40	Ele
Dorman 4AJ	T,B	TC	4-3.74x5.62	248.5	60-2200	17.0	4	575-1000	850	87	14.0	159-1000	844	VI	1.50-.420	1.31-.420	7½B	37½AB	52½BB	7½A	Ala	5.06	5	.....	CN	10.50	.....	C	Pin	1470	.40	H,E
Dorman 4DS	T,B	TC	4-3.54x4.72	186.2	50-2500	17.0	4	575-1000	850	85	18.0	120-1000	900	VI	1.56-.441	1.31-.441	7½B	35AB	45BB	7½A	Ala	4.37	5	2.41	3S11	9.50	4.68	C	Pin	1470	.40	H,E
English Electric H	R	DI	6-6x8	1357.2	200-1500	14.6	4	585-1500	858	78	34.3	700-1500	6860	VI	2.00-.575	1.75-.575	7½B	32½AB	47½BB	7½A	Ala	7.50	5	12.22	NS	17.50	28.75	C	Mul	2500	.39	Ele
Fowler-Sanders 2B	M,Tr,R	TC	2-4¼x6¼	177.3	30-1100	15.5	4	450-1100	800	122	44.6	109-850	1340	VI	1.50-.339	1.50-.338	5A	145B	135A	5A	CI	6.93	5	8.50	1035	13.57	10.45	C	Sin	2050	.40	H,E
Fowler-Sanders 3B	M,Tr,R	TC	3-4¼x6¼	265.9	45-1100	15.5	4	450-1100	800	122	42.2	159-1000	1900	VI	1.50-.339	1.50-.338	5A	145B	135A	5A	CI	6.93	5	8.50	1035	13.57	10.45	C	Sin	2060	.40	H,E
Fowler-Sanders 4B	M,Tr,R	TC	4-4¼x6¼	354.6	60-1100	15.5	4	450-1100	800	122	35.0	210-1000	2100	VI	1.50-.339	1.50-.338	5A	145B	135A	5A	CI	6.93	5	8.50	1055	13.57	10.45	C	Sin	2060	.38	H,E
Fowler-Sanders 4C	M,Tr,R	TC	4-7x9	1385.6	132-900	13.6	4	450-900	720	84	47.7	788-700	6300	VI	2.75-.613	2.62-.493	10B	135B	130A	5A	AI	10.02	5	22.65	1035	18.00	38.50	C	Sin	1860	.37	A,E
Fowler-Sanders 6B	M,Tr,R	TC	6-4¼x6¼	531.9	90-1100	15.5	4	450-1100	800	122	33.3	320-900	3000	VI	1.50-.339	1.50-.338	5A	145B	135A	5A	CI	6.93	5	8.50	1035	13.57	10.45	C	Sin	2060	.40	H,E
Fowler-Sanders 6A	Tr,R	TC	6-4.72x7.08	747.7	112-1100	14.5	4	450-1000	720	107	34.3	406-900	3840	VI	1.75-.408	1.75-.342	10B	136B	127A	10A	AI	7.59	5	7.60	CS	15.75	18.39	C	Sin	1860	.42	Ele
Fowler-Sanders 6C	M,Tr,R	TC	6-7x9	2078.4	200-900	13.6	4	450-900	720	85	40.5	1180-700	8100	VI	2.75-.613	2.62-.493	10B	135B	130A	5A	AI	10.02	5	22.65	1035	18.00	38.50	C	Sin	1860	.37	A,E
Glennifer (6) DB	M,R	TC	6-4⅜x6	637.6	72-1000	.....	4	400-	.....	90	45.5	378-	3280	HI	.....	.....	.....	.....	.....	.....	Ala	.....	6	.....	FS	.....	.....	C	Pin	1500	.44	Air
Kelvin (7)	M,R	TC	4-4.25x6.37	361.8	44-1000	16.0	4	570-	760	96	42.4	232-1000	1866	VI	.....	.....	.....	.....	.....	.....	Ala	.....	.....	.....	.....	.....	.....	.....	Pin	.....	.43	H,E
Kelvin (1)	M,R	TC	6-6x9	1525.8	132-750	15.0	4	570-	760	92	46.5	924-750	6146	VI	.....	.....	.....	.....	.....	.....	Ala	.....	.....	.....	.....	.....	.....	.....	Pin	.....	.39	A,H
Leyland T,Tr,B	T,Tr,B	PC	6-3½x5	288.6	65-1900	18.0	4	535-1000	....	94	15.9	194-1300	1035	VI	1.62-.444	1.43-.444	5B	35AB	224B	6A	AI	4.56	5	2.34	2340	10.31	3.25	C	Pin	1617	.40	Ele
Leyland T,Tr,B,R	T,Tr,B,R	DI	4-4½x5½	349.8	65-1900	16.5	4	500-1000	....	77	18.7	214-1200	1220	VI	2.00-.426	1.87-.426	8B	44AB	224B	8A	Ala	6.25	5	5.30	2340	11.50	6.00	C	Sin	2352	.37	Ele
Leyland T,Tr,B,R	T,Tr,B,R	DI	6-4½x5½	524.8	98-1900	16.5	4	500-1000	....	78	15.2	310-1050	1493	VI	2.00-.426	1.87-.426	8B	44AB	224B	8A	Ala	6.25	5	5.30	2340	11.50	6.00	C	Sin	2352	.37	Ele
Lister M	M	AC	1-4.50x4.37	69.5	8-1200	15.0	4	.....	.....	76	140.0	36-1000	1120	..	.....	.....	.....	.....	.....	.....	Ala	.....	.....	.....	.....	.....	.....	.....	.....	.....	.51	H
Lister M	M	AC	2-4.50x4.37	139.0	16-1200	15.0	4	.....	.....	76	89.2	73-1000	1428	..	.....	.....	.....	.....	.....	.....	Ala	.....	.....	.....	.....	.....	.....	.....	.....	.....	.51	H
Lister M	M	AC	2-4.50x5.50	174.9	21-1200	15.0	4	.....	.....	79	88.0	94-1000	1850	..	.....	.....	.....	.....	.....	.....	Ala	.....	.....	.....	.....	.....	.....	.....	.....	.....	.48	H
McLaren SLM	M,R	AC	4-3.74x4.92	216.0	30-1500	17.0	4	500-1500	750	73	36.7	115-1100	1100	VI	1.42-.400	1.42-.400	TC	35AB	130A	170BB	SA	4.64	5	6.00	NS	10.23	5.00	C	Pin	2500	.44	H,E,I
McLaren (8) LM	M,Tr,R	AC	6-4.13x5.90	475.0	66-1400	17.0	4	500-1400	750	79	30.5	300-1300	2014	VI	1.65-.411	1.65-.411	TC	35AB	130A	170BB	SA	5.55	5	6.75	NS	12.40	8.40	C	Pin	2500	.44	H,E
McLaren (8) LMX	M,Tr,R	AC	6-4.33x5.90	520.0	72-1400	17.0	4	500-1400	750	78	28.0	330-1300	2014	VI	1.65-.411	1.65-.411	TC	35AB	130A	170BB	SA	5.55	5	7.00	NS	12.40	8.40	C	Pin	2500	.44	H,E
McLaren (9) MDB	M,Tr,R	PC	8-5.31x7.87	1400.0	140-1000	15.0	4	500-1000	750	79	43.5	950-600	6100	VI	1.89-.470	1.89-.470	15B	19AB	132A	164BB	CI	8.61	5	16.75	NS	15.15	19.38	C	Pin	1500	.47	A,E
McLaren (9) MDBX	M,Tr,R	PC	8-5.59x7.87	1560.0	154-1000	15.0	4	500-1000	750	78	39.6	1045-600	6100	VI	1.89-.470	1.89-.470	15B	19AB	132A	164BB	CI	8.61	5	16.75	NS	15.15	19.38	C	Pin	1500	.47	A,E
McLaren (10) M40	M,R	PC	8-7.48x9.44	2724.0	320-1000	15.0	4	500-1000	750	93	35.2	2044-580	11260	VI	2.91-1.10	2.91-1.10	15B	43AB	130A	165BB	CI	10.23	5	27.00	NS	21.63	60.00	C	Pin	1500	.46	Air
McLaren (10) M44	M,R	PC	8-7.87x9.44	3660.0	350-1000	15.0	4	500-1000	750	76	32.2	2240-580	11260	VI	2.91-1.10	2.91-1.10	15B	43AB	130A	165BB	CI	10.23	5	30.00	NS	21.63	66.00	C	Pin	1500	.44	Air
Meadows 4M.L.	M,T,Tr,R	AC	4-4.13x5.90	318.8	74-2000	12.0	4	.....	.....	92	13.3	218-1500	990	VI	1.62-.432	1.50-.432	20B	35AB	145A	172BB	Ala	5.96	4	4.25	CN	11.37	8.00	C	Pin	1470	.40	Ele
Mirrless Comet (11) Z	M,R	TC	8-6¼x6½	1600.0	200-1200	16.6	4	580-1200	860	82	46.0	960-1200	9195	VI	2.62-.781	2.12-.625	15B	35AB	45BB	15A	Ala	8.25	5	14.75	NS	17.00	26.00	C	Pin	2500	.41	A,E
Mirrless Comet (11) U	M,R	TC	8-8x12	4824.0	480-900	15.0	4	530-900	760	87	44.8	2800-900	21521	VI	3.50-1.00	2.81-.812	7½B	35AB	45BB	7½A	Ala	11.50	5	32.50	NS	29.50	46.00	C	Pin	3300	.38	A,E
Paxman-Ricardo (12) RQ	M,R	TC	6-4⅝x5⅞	592.5	90-1500	18.0	4	615-1500	750	80	.....	318-1500	.....	VI	1.87-	1.50-	7½B	27½AB	37½BB	7½A	Ala	5.56	6	.....	NS	11.78	10.50	C	Pin	1800	.42	A,E,H
Paxman-Ricardo (13) RW	M,R	TC	8-5½x7	1328.0	210-1500	16.0	4	550-1500	780	84	.....	736-1500	.....	VI	2.25-	1.81-	7½B	27½AB	37½BB	7½A	Ala	8.50	6	.....	NS	14.00	17.68	C	Pin	1800	.42	A,E
Paxman-Ricardo (14) VRB	M,R	TC	12-7x7¾	3972.0	600-1500	15.5	4	550-1500	800	80	.....	2120-1500	.....	VI	3.00-	2.75-	30B	40AB	55BB	30A	Ala	7.00	5	.....	NS	16.00	(a)	C	Pin	1800	.40	A,E
Sirron (12)	M,Tr,R	TC	6-4.13x5.98	480.4	60-1000	18.0	4	500-1000	900	99	.....	.....	.....	VI	1.61-.393	1.61-.393	10B	30AB	135A	170BB	CI	5.98	5	.....	FS	.....	.....	C	Mul	2000	.43	A,H
CZECHOSLOVAKIAN																																	
Skoda (12) 6S-110	M,Tr	PC	6-4.33x5.90	521.5	60-1200	16.0	4	498-1200	768	76	36.4	271-600	2183	VI	1.65-.551	1.65-.551	16B	40AB	45BB	10A	Ala	6.61	5	5.29	CN	11.81	10.58	C	Mul	3234	.44	A,E,H
Skoda R230-6	R	DI	6-9.05x11.02	4252.9	400-1000	16.0	4	498-1000	853	75	24.7	2238-820	9878	VI	2.75-.591	2.75-.591	20B	46AB	48BB	10A	Ala	11.37	7	40.66	CN	22.04	50.70	O	Mul	4410	.41	A,E
Skoda (15) 6R-140	M,R	DI	6-5.51x7.87	1127.2	150-1500	14.5	4	427-1500	825	70	8.3	550-900	2745	VI	1.65-.512	1.65-.512	25B	45AB	15BB	55A	Ala	7.08	6	8.60	CN	15.35	16.32	C	Mul	4410	.43	A,E
Skoda (2) 133-8 DH	T,R	TC	8-4.33x5.90	718.5	133-1600	17.2	4	512-1000	995	92	6.6	466-1000	2205	VI	1.65-.433	1.65-.433	13B	48AB	40BB	14A	Ala	6.61	6	6.68	Stl	13.54	12.90	C	Sin	2205	.44	Ele
Skoda (4) 180-8 DH	T,R	TC	8-4.92x6.29	958.0	180-1600	17.2	4	512-1000	995	93	14.1	603-800	2536	VI	1.89-.433	1.89-.433	13B	48AB	40BB	14A	Ala	7.00	6	8.71	Stl	13.54	18.41	C	Sin	2205	.44	Ele
FINNISH																																	
Ares W2-130KP	M	DI	2-5.11x6.29	259.5	30-1100	6.20	4	.....	.....	83	35.3	.....	1058	VI	1.96-	1.96-	7B	30AB	45B	5BB	CI	5.90	7	.....	CN	13.77	.....	C	Mul	1837	.47	H,E
Ares W6-100KP	M	DI	6-3.93x4.72	344.8	75-2200	.....	4	.....	.....	78	11.7	.....	882	VI	1.65-	1.65-	6B	25AB	45B	6BB	Ala	4.72	7	.....	CN	9.05	.....	C	Mul	1764	.48	Ele

Ares	W6-160KP	M	DI	6	6.29	x7.87	1471.2	180–1200	6.20	4				81	18.4		3307	VI	2.48–		2.48–		10B	25AB	40B	6BB	CI	7.48	7		CN	13.77		C	Mul	1764	.46	Ele
Ares	W8-190KP	M	DI	8	7.48	x9.44	3320.0	520–1150		4				108	9.7		5070	VI	2.67–		2.55–		12B	25AB	40B	7BB	AIa	9.84	7		CN	17.71		C	Mul	2058	.45	Ele
FRENCH																																								
Berliet	MDFC	C,Tr,TB	TC	4	4.33	x5.90	347.7	75–2000	17.0	4	498–		853	86	19.7	211–1400	1477	VI	1.77–.425		1.57–.425		10B	38½AB	41½BB	10A	AI	6.88	7	5.73	CN	12.40	8.04	C	Sin	1470	.44	Ele
Berliet	MDBR	C,Tr,T,B	TC	4	4.72	x6.29	439.2	90–1800	16.5	4	498–		853	90	19.8	266–1300	1785	VI	1.88–.472		1.73–.472		10B	38½AB	41½BB	10A	AI	6.88	7	7.14	CN	12.00	10.16	C	Sin	1470	.43	Ele
Berliet	MDCC	C,Tr,T,B	TC	6	4.33	x5.90	524.6	115–2000	17.0	4	498–		853	87	18.2	312–1400	2094	VI	1.77–.425		1.57–.425		10B	38½AB	41½BB	10A	AI	6.88	7	5.73	CN	12.40	8.04	C	Sin	1470	.44	Ele
Berliet	MDKC	R	TC	6	5.31	x7.08	945.5	150–1500	16.0	4	498–		853	84	17.6	578–1100	2645	VI	2.04–.535		1.81–.535		10B	38½AB	41½BB	10A	AI	7.28	7	11.00	CN	13.78	12.79	C	Sin	1470	.41	Ele
Berliet	MDKC	R	TC	6	5.31	x7.08	945.5	150–1500	16.0	4	498–		853	84	17.6	578–1100	2645	VI	2.04–.535		1.81–.535		10B	38½AB	41½BB	10A	AIa		5		Stl			C	Sin	1422	.44	H,E
Citroen	7CV	C,T,B	TC	4	2.95	x3.93	107.7	40–3500	19.0	4	569–			84	11.1		445	VI	1.41–.354		1.24–.354		10B	40AB	50BB	6A•	Per	6.49	6	12.45	CN	10.63	15.87	C	Mul	3234	.37	A,E
Lilloise	8DV-120	M,R	DI	8	4.72	x11.81	1654.3	500–1500	15.5	2	512–500		1137	80	8.38	1832–750	4188						Two	Cycle			Per		4	6.13	CN	7.95	2.32	O		3675	.42	A,E
Lilloise	6DV-85	M,C,T,Tr,B,R	DI	6	3.34	x8.26	435.5	150–2100	16.5	2	512–500		1137	65	9.55	376–2100	1433						Two	Cycle			Per	4.52	4	2.36	CN	5.74	1.73	O		3675	.46	H,E
Lilloise	6DV-60	M,C,T,Tr,B,R	DI	6	2.36	x5.90	133.7	90–3000	16.5	2	512–500		1137	89	7.83	195–1000	705						Two	Cycle															
Peugeot	HL50	T	TC	4	3.07	x4.72	140.3	53–3250	17.0	4	568–2000		782	92	9.55	94–2500	507	VI	1.33–.276		1.18–.276		5B	49AB	55BB	20A	AI	4.09	5	1.52	NS	9.05	3.00		Pin	924	.45	Ele
Renault	4C-100	M,T,Tr,B	TC	4	3.93	x5.90	287.3	70–2200	15.5	4	568–2200		739	88	16.8	177–1700	1179	VI	1.73–.393		1.73–.393		11½B	35½AB	31B	15BB	AIa	7.28	5	8.59	CN	14.56	10.09	C	Mul	2940	.41	Ele
Renault	4C-125	M,T,Tr,B	DI	4	4.92	x6.69	508.7	85–1600	15.5	4	540–1500		1066	83	20.5	297–1000	1741	VI	1.96–.393		1.96–.393		11½B	35½AB	31B	15BB	AIa	7.28	5	8.59	CN	14.56	10.09	C	Mul	2940	.41	Ele
Renault	6C-125	M,T,Tr,B,R	DI	6	4.92	x6.69	762.5	125–1500	15.5	4	540–1500		1066	86	19.2	485–1300	2403	VI	1.96–.393		1.96–.393		11½B	35½AB	31B	15BB	AIa	7.36	6	12.21	CN	16.33	33.95	C	Mul	2940	.40	Ele
Renault	12V-140	M,R	DI	12	5.51	x6.69	1914.7	300–1500		4	568–1500		1137	83	16.1	1084–900	4850	VI	1.57–.374		1.41–.374		10B	26AB	45B	5BB	AI		5					C	Pin	1280	.44	Ele
Rochet-Schneider	425	C,T,Tr,B	TC	4	4.33	x5.90		80–1900	15.0	4						217–1200		VI									AI		5					C	Pin	1280	.44	Ele
Rochet-schneider	355	C,T,Tr,B	TC	6	4.33	x5.90		115–1800	15.0	4						325–1200		VI									AI	5.78	5	4.51	CN	12.00	4.62	C	Mul	720	.50	Ele
Somua	MSF	C,T,Tr,B	DI	6	4.64	x5.90	600.3	125–2000	6.3	4				83		361–1200		VI	2.08–.472		1.73–.472		6A	50AB	50B	5A	AI	5.78	5	4.51	CN	12.00	4.62	C	Mul	720	.50	Ele
Somua	MF	C,T,Tr,B	DI	4	4.64	x5.90	400.2	85–2000	6.3	4				84		242–1200		VI	2.08–.472		1.73–.472		6A	50AB	50B	5A	AI	5.78	5	4.51	CN	12.00	4.62	C	Mul	720	.50	Ele
Unic	M25E	C,T,Tr,B	PC	4	4.33	x5.11	301.4	65–2500	17.0	4	668–1500		824	68	15.9	188–1200	1036	VI	1.49–.488		1.49–.488		TC	35AB	45B	8BB	AIs	6.51	5	5.41	CN	10.84	6.94	C	Sin	1066	.45	Ele
Unic	M20E	C,T,Tr,B	PC	6	4.13	x6.49	519.8	95–1600	16.0	4	640–1200		810	91	18.8	321–1200	1785	VI	1.49–.433		1.49–.433		10B	35AB	45B	10BB	AIs	6.37	5	4.71	CN	12.99	8.78	C	Sin	1066	.45	Ele
Unic	M26	C,T,Tr,B	PC	6	4.52	x6.49	627.2	110–1600	16.0	4	640–1200		824	87	17.0	397–1200	1873	VI	1.49–.488		1.49–.488		10B	35AB	45B	10BB	AIs	6.61	5	5.85	CN	12.79	10.70	C	Sin	1066	.45	Ele
GERMAN																																								
Bussing NAG	LD3	T,Tr,B	PC	3	4.33	x5.11	226.0	45–2000	17.5	4	469–		640	79	20.8	134–1200	937	VI	1.89–.410		1.69–.410		5B	35AB	35BB	5A	AIa	6.61	5	5.07	Stl	10.63	7.16	C	Pin	1396	.48	Ele
Bussing NAG	LD4	T,Tr,B	PC	4	4.33	x5.11	301.4	60–2000	17.5	4	469–		640	79	19.3	187–1200	1157	VI	1.89–.410		1.69–.410		5B	35AB	35BB	5A	AIa	6.61	5	5.07	Stl	10.63	7.16	C	Pin	1396	.48	Ele
Bussing NAG	LD5	T,Tr,B	PC	5	4.33	x5.11	376.7	75–2000	17.5	4	469–		640	79	18.2	237–1200	1367	VI	1.89–.410		1.69–.410		5B	35AB	35BB	5A	AIa	6.61	5	5.07	Stl	10.63	7.16	C	Pin	1396	.48	Ele
Bussing NAG	LD6	T,Tr,B	PC	6	4.33	x5.11	452.1	90–2000	17.5	4	469–		640	79	16.3	266–1200	1466	VI	1.89–.410		1.69–.410		5B	35AB	35BB	5A	AIa	5.19	6	2.42	Stl	10.63	4.85	C	Pin	1396	.55	Ele
Bussing NAG	ZD4	T,B	PC	4	3.62	x4.92	202.6	55–2600	18.5	4	512–		711	83	12.4	126–1400	681	VI	1.49–.394		1.37–.394		10B	40AB	40BB	10A	AIa	7.44	5	7.49	Stl	13.77	12.56	C	Pin	1396	.51	Ele
Bussing NAG	GD4	T,Tr,B,R	PC	4	5.11	x6.69	550.5	80–1300	17.0	4	469–		640	89	19.9	326–800	1598	VI	2.04–.394		2.04–.394		10B	45AB	45BB	10A	AIa	7.46	5	6.83	Stl	13.77	12.56	C	Pin	1396	.50	Ele
Bussing NAG	FD6	T,Tr,B,R	PC	6	4.92	x6.69	763.5	110–1300	17.0	4	469–		640	88	17.8	482–800	1962	VI	2.04–.394		2.04–.394		10B	45AB	45BB	10A	AIa	7.44	5	7.49	Stl	13.77	12.56	C	Pin	1396	.51	Ele
Bussing NAG	GD6	T,Tr,B,R	PC	6	5.11	x6.69	825.8	130–1500	17.0	4	469–		640	83	15.4	515–800	2006	VI	2.04–.394		2.04–.394		10B	45AB	45BB	10A	AIa	7.44	5	8.15	Stl	13.77	13.23	C	Pin	1396	.55	Ele
Bussing NAG	UD6	T,Tr,B,R	PC	6	5.31	x6.29	838.2	140–1400	17.5	4	469–		640	95	18.1	550–800	2535	VI	2.12–.394		2.12–.394		5B	35AB	35BB	5A	AIa										.44	Ele
D.W.K.	2X4V18V	R	PC	8	5.03	x7.08	1128.9	180.1500		4	735–		735	84	16.3		2932	VI									AI										.44	Ele
D.W.K.	12V19	R	PC	12	5.11	x7.48	1861.2	275–1500		4	735–		735	78	18.4		5070	VI									AIa	6.49	5	5.07	CM	13.89	9.04	C	Sin	1764	.46	H,E
Famo	2F145	C,T,Tr	PC	2	4.13	x5.70	153.1	25–1500	16.8	4	498–1500		782	86	37.0	90–1000	926	VI	1.57–.472		1.57–.472		25B	55AB	60BB	20A	AIa	6.49	5	5.07	CM	11.73	8.53	C	Sin	1764	.46	H,E
Famo	4F145	C,T,Tr	PC	4	4.13	x5.70	306.2	50–1350	18.0	4	498–1350		782	96	26.9	180–1350	1345	VI	1.57–.472		1.57–.472		20B	40AB	60BB	20A	AIa	6.49	5	5.07	CM	11.73	8.53	C	Sin	1764	.46	Ele
Famo	6F145	C,T,Tr	PC	6	4.13	x5.70	459.3	75–1500	16.8	4	498–1500		782	86	19.7	271–1000	1477	VI	1.57–.472		1.57–.472		25B	55AB	60BB	20A	AIa	7.44	5	8.38	CM	16.33	13.23	C	Sin	1764	.46	H,E
Famo	2F175	C,T,Tr	PC	2	4.92	x6.89	262.3	41–1500	16.8	4	498–1500		782	83	29.6	173–1000	1213	VI	1.89–.591		1.89–.591		25B	55AB	60BB	20A	AIa	7.44	5	8.38	CM	13.78	13.23	C	Sin	1764	.46	H,E
Famo	4F175	C,T,Tr	PC	4	4.92	x6.89	525.2	65–1100	17.0	4	498–1500		782	89	25.4	347–1150	1654	VI	1.89–		1.89–		20B	40AB	60BB	20A	AIa										.48	Ele
Hanomag	D19A	C	PC	4	3.14	x3.74	115.9	32–3000	22.0	4	597–2000		924	73		65–2000		VI	1.24–.354		1.16–.354		10B	20AB	40BB	6A	AI	3.91	5	1.41	Stl	7.48	2.67	C	Pin	1470	.48	Ele
Hansa-Lloyd	D6M3,6	T	TC	6	3.07	x4.92	218.6	55–2400	17.0	4	661–2000		1038	83	16.0	130–1000	870	VI	1.22–.315		1.14–.315		10B	50AB	56BB	4A	AI	4.52	5	1.62		9.84	3.46	C	Sin	1617	.48	Ele
Henschel-Lanova	T	T,B	AC	4	4.13	x5.51	295.5	65–2000	12.5	4	384–1000		640	87	17.0	540–1200	1102	VI	1.61–.393		1.61–.393		16B	40A	34B	10A	AIa	6.06	4	3.30		12.20	9.37	C	Pin	1470	.46	Ele
Henschel-Lanova	S	T,B	AC	6	4.13	x5.51	443.7	95–2000	12.5	4	384–1000		640	85	16.3	540–1200	1543	VI	1.61–.393		1.61–.393		16B	40A	34B	10A	AIa	6.06	4	2.54		12.20	9.37	C	Pin	1470	.46	Ele
Henschel-Lanova	G	T,B	AC	6	4.33	x6.29	557.5	100–1500	12.5	4	384–800		640	95	16.9	383–900	1697	VI	1.73–.354		1.73–.354		16B	40AB	34BB	10A	AIa	6.69	6	4.63	Stl	13.58	12.90	C		1470	.46	H,E
Humboldt-Deutz	F4M513	M,T,B	PC	4	4.33	x5.11	301.4	70–2000		4				92	15.7		1102	HI																	C		1849	.45	Ele
Humboldt-Deutz	F6M513	M,T,B	PC	6	4.33	x5.11	452.1	105–2000		4				92	14.7		1543	HI																	C		1849	.45	Ele
Humboldt-Deutz	F4M516	M,T,B	PC	4	4.33	x6.29	370.9	85–2000		4				91	13.5		1146	HI																	C		1849	.45	Ele
Humboldt-Deutz	F6M516	M,T,B	PC	6	4.33	x6.29	556.4	125–2000		4				89	12.8		1609	HI																	C		1849	.44	Ele
Humboldt-Deutz	F4M517	M,T,B	PC	4	5.11	x6.69	550.2	100–1600		4				90	18.0		1807	HI																	C		1849	.44	Ele
Humboldt-Deutz	F6M517	M,T,B	PC	6	5.11	x6.69	825.8	150–1600		4				90	14.5		2182	HI																	C		2133	.44	Ele
Humboldt-Deutz	F8M517	M,T,B	PC	8	5.11	x6.69	1101.1	200–1600		4				90	11.8		2353	HI																						
Junkers-Fahrzeug	2,7	C,T,B,R	DI	2	3.34	x9.45	166.1	55–1500	17.0	2	568–		853	87	17.2	231–700	948						Two	Cycle			Per				NS	(b)			Sin	4410	.44	Ele
Junkers-Fahrzeug	4,1	C,T,B,R	DI	3	3.34	x9.45	249.2	90–1500	17.0	2	568–		853	96	14.7	325–700	1323						Two	Cycle			Per				NS	(b)			Sin	4410	.44	Ele
Junkers-Fahrzeug	5,4	C,T,B,R	DI	4	3.34	x9.45	332.3	120–1500	17.0	2	568–		853	96	13.7	455–700	1653						Two	Cycle			Per				NS	(b)			Sin	4410	.44	Ele
Junkers-Fahrzeug	7,1	C,T,B,R	DI	4	3.93	x9.45	459.9	150–1500	16.0	2	568–		853	86	14.4	600–1000	2160						Two	Cycle			Per				NS	(b)			Sin	4410	.44	Ele
Kamper (16)	4F1(	M,T,Tr,B,R	TC	4	3.93	x5.59	271.4	55–1800	18.0	4	568–		711	89	15.8	166–1300	870	VI	1.73–		1.73–		2B	39AB	43BB	9A	AI	5.51	4	4.62	CN	11.22	5.67	C	Pin	1176	.46	H,E(x)
Kamper (17)	6D12	M,T,Tr,B,R	TC	6	4.72	x6.69	702.7	120–1500	16.0	4	568–		711	90	16.5	413–1200	1984	VI	2.04–		2.04–		2B	39AB	43BB	9A	AI	6.77	4	7.05	CN	15.35	13.22	C	Pin	1176	.46	H,E(x)
Krupp	M612	T	PC	4	3.93	x5.11	248.8	55–2200	18.4	4	568–1600		782	80	18.4	144–1600	1014	HI	1.65–.393		1.57–.393		5B	40AB	55BB	5A	AI	6.29	5	3.74	SMa	10.03	6.61	C	Pin	1396	.57	Ele
Krupp (7)	M422	T	DI	4	3.34	x9.45	331.8	115–1500	17.0	2	540–1100		924	91	17.2	448–1200	1984						Two	Cycle			CI	(c)	5	(d)	CM	(b)		O	Pin	5880	.44	Ele
M.A.N. (4)	D-0534	T,Tr,B	DA	4	4.13	x5.11	274.6	65–2200		4				85	15.2	159–1400	992	VI									AI	6.10	4	4.06	CM	9.84	6.78	C	Pin	1911	.44	Ele
M.A.N.	D-2040	T,Tr,B	DA	6	4.72	x5.51	579.5	120–2000		4				82	14.5	354–1200	1742	VI									AI	6.49	4	7.06	CM	11.22	9.92	C	Pin	1911	.44	Ele
M.A.N.	D-1040	T,Tr,B	DA	6	4.33	x5.51	486.9	100–1900		4				86	13.7	282–1400	1367	VI									AI	5.98	4	4.19	CM	10.82	7.30	C	Pin	1911	.44	Ele
M.A.N.	D-3555	T,Tr,B	DA	6	5.31	x6.10	812.0	150–1700		4				86	14.5	477–1200	2183	VI									AI	7.55	5	10.01	CM	11.81	11.79	C	Pin	1911	.44	Ele
M.A.N.	W6V12-18	R	DP	6	4.72	x7.08	745.2	105–1500		4				74	26.2		2756	VI																	C	Sin	1837	.44	A,E
M.A.N. (3)	W6V17.5-22	R	DP	6	6.89	x8.66	1933.7	200–1000		4				82	22.9		4586	VI																	C	Sin	1837	.43	A,E
M.A.N.	W6V22-30	R	DP	6	8.66	x11.81	4172.4	360–850		4				80	18.6		6725	VI																	C	Sin	2648	.38	A,E
M.A.N.	L12V17.5-18	R	DP	12	6.89	x7.08	3159.8	420–1400		4				75	15.2		6394	VI																	C	Sin	2648	.41	A,E
M.A.N.	W12V13-19	R	DP	12	5.11	x7.48	1842.2	275–1500		4				79	20.0		5512	HI																	C	Sin	1837	.44	A,E
Maybach (18)	GO6	M,R	DI	12	6.29	x7.87	2942.6	600–1400		4				115	8.45		5070	VI									AI				Stl			C	Mul	2940	.39	Ele
Maybach	GO5E	M,R	DI	12	6.29	x7.87	2942.6	410–1400		4				78	11.2		4629	VI									AI				Stl			C	Mul	2940	.41	Ele
Maybach	GO56H	M,R	DI	6	6.29	x7.87	1471.3	225–1450		4				83	12.7		2866	VI									AI				Stl			C	Mul	2940	.41	Ele
Maybach	GO40	M,R	DI	6	5.51	x7.08	1013.8	150–1600		4				73	13.9		2094	VI																						
M.W.M.	GS113V	C,T,Tr,B,R,M	AC	4	4.05	x5.11	284.3	55–2000	17.5	4	512–2000		711	82	16.8	174–1200	926	VI					5B	47AB	124A	168BB	AIa	5.63	6	3.75	CM	11.02	7.20	C	Pin	1911	.43	H,E
M.W.M.	SS215V	C,T,Tr,B,R,M	AC	4	4.33	x5.90	347.7	70–1800	17.5	4	512–1800		711	89	16.6	210–1200	1168	VI					TC	35AB	130A	170BB	AIa	5.90	6	4.41	CM	12.00	7.94	C	Pin	1911	.43	A,E
M.W.M.	SS17V	C,T,Tr,B,R,M	AC	4	4.92	x6.69	509.0	90–1600	17.5	4	512–1600		711	88	18.6	354–1200	1675	VI					5B	40AB	125A	170BB	AIa	6.57	6	6.39	CM	14.17	12.57	C	Pin	1911	.43	A,E
M.W.M.	SS215S	C,T,Tr,B,R,M	AC	6	4.33	x5.90	521.5	105–1800	17.5	4	512–1800		711	89	15.3	311–1200	1609	VI					TC	35AB	130A	170BB	AIa	5.90	6	4.41	CM	12.00	7.94	C	Pin	1911	.43	A,E
M.W.M.	SS17S	C,T,Tr,B,R,M	AC	6	4.92	x6.69	763.5	135–1600	17.5	4	512–1600		711	87	17.1	448–1200	2315	VI					5B	40AB	125A	170BB	AIa	6.57	6	6.39	CM	14.17	12.57	C	Pin	1911	.43	A,E

AUTOMOTIVE DIESEL AND OTHER HEAVY OIL ENGINES—continued

MAKE AND MODEL	Designed for	Type	Number of Cylinders Bore and Stroke (In.)	Piston Displacement (Cu. In.)	Rated Brake Hp. at Specified R.P.M.	Compression Ratio—to 1	Cycle	Compression Pressure at Specified R.P.M.	Maximum Pressure (Lb. per Sq. In.)	B.M.E.P. at Maximum Hp. (Lb. per Sq. In.)	Weight per Rated Brake Hp. (Lb.)	Maximum Torque in Lb. Ft. at Specified R.P.M.	Weight Equipped (Lb.)	Arrangement	Intake Port Diameter and Lift (In.)	Exhaust Port Diameter and Lift (In.)	Timing (Degrees) Inlet Opens	Inlet Closes	Exhaust Opens	Exhaust Closes	Pistons Material	Pistons Length (In.)	Pistons No. of Rings per Piston	Pistons Weight with Rings and Pin (Lb.)	Connecting Rods Material	Connecting Rods Center to Center Length (In.)	Connecting Rods Weight with Cap and Bushings (Lb.)	Injection Valve Valve Type, Open or Closed	Injection Valve Type Orifices Single, Multiple or Pintle	Injection Valve Injection Pressure (Lb. per Sq. In.)	Injection Valve Fuel Consumption at Rated Load (Lb. per B. Hp. Hr.)	Starting Method
GERMAN—continued																																
Vomag 4R1560	C,T,Tr	TC	4-4.53x6.30	405.5	84-1500	14.2	4	483-	853	109	16.4	260-1200	1367	VI	2.16-	2.16-	8B	42AB	42BB	8A	Ala	6.85	5	.....	Stl	12.79	.....	C	.....	1764	.46	Ele
Vomag 4R3080	C,T,Tr	TC	4-5.11x7.08	582.9	100-1500	14.2	4	455-	853	91	18.6	369-1000	1863	VI	1.77-	1.77-	10B	45AB	45BB	10A	Ala	7.68	5	.....	Stl	14.57	.....	C	.....	1249	.46	Ele
Vomag 6R3080	C,T,Tr,B	TC	6-5.11x7.08	874.3	150-1400	14.2	4	455-	853	97	16.5	608-1000	2480	VI	2.16-	2.16-	10B	45AB	45BB	10A	Ala	7.68	5	.....	Stl	14.57	.....	C	.....	1249	.47	Ele
Vomag 6R3080	M,R	TC	6-5.11x7.08	874.3	142-1500	14.2	4	427-	853	86	17.0	506-1100	2425	VI	2.16-	2.16-	10B	45AB	45BB	10A	Ala	7.68	5	.....	Stl	14.57	.....	C	.....	1249	.46	Ele
Vomag 6R4080	M,R	TC	6-5.51x7.08	1013.8	172-1500	14.5	4	469-	853	90	19.8	615-1100	3417	HI	2.16-	2.16-	8B	42AB	42BB	8A	Ala	7.40	5	.....	Stl	16.14	.....	C	.....	1837	.46	Ele
Vomag 8R3580	M,R	TC	8-5.31x7.08	1257.2	200-1500	14.5	4	469-	853	84	20.9	738-1000	4189	HI	.....	.....	14B	34AB	32BB	15A	Ala	7.83	5	.....	Stl	16.14	.....	C	.....	1837	.46	Ele
Vomag 8R4080	M,R	TC	8-5.51x7.08	1351.7	230-1500	14.5	4	469-	853	90	18.4	796-1100	4244	HI	2.16-	2.16-	8B	42AB	42BB	8A	Ala	7.40	5	.....	Stl	16.14	.....	C	.....	1837	.46	Ele
HUNGARIAN																																
Ganz-Jendrassik (2) JAR-110	T,B,M,R	PC	8-4.33x5.90	695.4	113-1650	13.0	4	427-1650	583	78	19.5	690-1000	2205	VI	1.89-.472	1.57-.472	10B	35AB	55BB	5A	Ala	5.47	5	4.19	NS	11.61	6.39	O	Sin	2058	.42	Ele
Ganz-Jendrassik (19) JHR-130	M	PC	4-5.11x6.30	517.9	48-1000	12.6	4	427-1000	569	73	54.2	325-750	2602	VI	1.81-.531	1.53-.488	10B	35AB	55BB	3A	CI	6.69	5	15.12	NS	12.91	14.02	O	Sin	2058	.44	A,H
Ganz-Jendrassik JAR-135	R	PC	6-5.31x7.28	976.0	130-1400	13.0	4	427-1400	583	75	24.6	694-1000	3197	VI	2.36-.630	1.97-.630	10B	35AB	55BB	5A	Ala	6.50	5	7.71	NS	14.57	17.64	O	Sin	2058	.40	Ele
Ganz-Jendrassik (20) JMR-160	M	PC	8-6.30x7.28	1814.1	165-1000	12.6	4	427-1000	569	72	35.4	1113-750	5843	VI	2.36-.630	1.97-.551	10B	35AB	55BB	5A	CI	7.56	5	25.11	NS	14.57	25.70	O	Sin	2058	.43	Air
Ganz-Jendrassik (21) JAR170-240	M,R	PC	8-6.69x9.45	2757.1	340-1250	13.0	4	427-1250	583	78	22.0	.....	7497	...	3.07-.760	2.76-.732	10B	35AB	55BB	5A	Ala	7.87	4	14.99	NS	18.90	27.33	O	Sin	2058	.40	A,E
Ganz-Jendrassik JOR216-310	M	PC	8-8.50x12.20	5540.6	400-750	12.0	4	427-	569	76	57.9	3398-620	23152	...	2.76-.697	2.28-.646	10B	35AB	55BB	5A	Ala	10.35	5	28.43	NS	24.41	55.99	O	Sin	2058	.37	Air
ITALIAN																																
Alfa Romeo F6M313	T,B	PC	6-3.94x5.12	373.6	80-2000	19.0	4	540-1200	....	85	15.6	235-1200	1250	VI	1.57-.437	1.57-.437	15B	55AB	45B	25BB	Ala	6.02	5	4.19	CN	11.81	8.60	C	Sin	1912	.46	Ele
Alfa Romeo F6M317	T,B,R	PC	6-4.72x6.69	701.5	125-1600	19.0	4	540-1200	....	88	18.2	419-1200	2278	VI	1.89-.571	1.89-.571	19B	59AB	59B	19BB	Ala	6.97	5	6.74	CN	14.37	12.63	C	Sin	1912	.44	Ele
Ansaldo Q122-8V	R	PC	8-4.80x6.89	998.4	130-1400	16.5	4	569-1400	711	74	23.2	.....	3018	VI	1.89-.512	1.89-.512	10B	44AB	44BB	10A	Ala	6.30	8	6.92	Stl	13.78	13.93	..	Sin	1176	.46	Ele
Bianchi M-68	T,B	PC	4-4.13x5.51	295.7	68-2000	17.0	4	441-	....	91	17.6	173-1650	1199	VI	1.50-	1.50-	5B	35AB	40BB	5A	....	6.30	4	4.52	Stl	11.42	7.39	..	Pin	1249	.46	Ele
Fiat 324	T,B	TC	4-4.25x4.92	279.4	55-2200	17.3	4	484-2200	924	71	23.6	144-1500	1301	VI	1.81-.453	1.69-.453	10B	44AB	44BB	10A	Al	5.21	6	4.19	3435	11.22	7.72	C	Sin	1470	.46	Ele
Fiat 355C	T,B,R	DI	6-4.25x5.98	509.3	85-1700	13.5	4	455-1700	740	78	23.1	268-1200	1962	VI	1.85-.453	1.57-.413	8B	40AB	60BB	20A	Al	6.50	6	5.23	3435	12.52	8.38	C	Mul	2205	.43	Ele
Fiat 356	B,R	TC	6-4.53x6.30	608.2	120-1800	17.6	4	498-1800	924	87	17.5	354-1400	2094	VI	2.00-.492	1.69-.453	10B	44AB	44BB	10A	Al	6.85	6	5.84	3435	12.99	8.40	C	Sin	1470	.45	Ele
Fiat 357	R	TC	6-4.92x6.89	784.1	145-1700	17.2	4	484-1700	924	86	21.3	448-1300	3087	VI	1.97-.531	1.77-.531	5B	40AB	45BB	TC	Al	7.87	6	8.35	3435	14.88	15.18	C	Sin	1470	.45	Ele
Fiat V1612	R	DI	12-6.30x7.09	2649.1	500-1700	12.5	4	427-1700	924	88	9.8	1295-1300	4916	VI	2.16-	2.16-	10B	50AB	50BB	10A	Al	7.87	6	14.77	3435	14.96	17.53	C	Mul	3281	.42	Ele
Lario (19) M.N.60	M	DI	4-3.35x5.51	193.7	60-1400	16.0	2	427-	682	93	18.3	217-1400	1102	VI			Two	Cycle			CI	5.84	6	4.48	Stl	11.02	3.81	C	Mul	2205	.46	H,E
JAPANESE																																
Hatsudoki 4PH-25B	R	PC	4-4.92x7.87	600.2	60-1100	18.0	4	498-	782	72	58.8	325-900	3528	VI	1.77-.394	1.77-.394	20B	44AB	60B	22AB	CI	7.79	6	12.79	CN	16.30	18.08	C	Pin	1176	.48	Ele
Ikegai 4HSD10	T,B	TC	4-3.94x5.51	268.4	50-2000	17.0	4	.....	....	74	17.2	148-1200	860	VI	1.65-.433	1.65-.433	.....	.....	.....	.....	CI	.....	4	.....	FS	.....	.....	C	Pin	.....	.43	Ele
Mitsubishi 650AV	T,B	DI	6-4.14x5.11	411.9	70-1900	13.5	4	.....	....	71	14.2	.....	992	VI	1.89-.571	1.89-.571	.....	.....	.....	.....	CI	.....	.....	.....	CN	.....	.....	C	Pin	.....	.42	Ele
Mitsubishi SHT6	T,B	PC	6-4.14x5.51	443.4	70-1850	16.0	4	.....	....	68	18.9	217-1000	1323	VI	1.69-.433	1.61-.394	.....	.....	.....	.....	CI	.....	.....	.....	CN	.....	.....	C	Pin	.....	.44	Ele
Nigata K8C	R	DI	8-9.84x11.42	7442.0	600-900	14.0	4	611-900	924	71	28.4	3760-880	17023	VI	3.15-.787	3.15-.787	15B	30AB	50BB	20A	Ala	13.18	7	81.58	FS	22.44	92.61	C	Mul	4410	.40	Ele
Nigata K6D	R	DI	6-9.84x12.20	5563.2	500-900	14.8	4	611-900	754	79	26.0	3181-900	13009	VI	2.83-.709	2.83-.709	15B	30AB	50BB	20A	Ala	14.37	7	81.58	FS	24.40	101.4	C	Mul	4704	.43	Ele
Nigata T6Y	M	AC	6-9.26x12.20	4922.7	350-750	15.0	4	483-750	711	75	26.5	2603-775	9261	VI	2.75-.669	2.75-.669	25B	20AB	48BB	20A	Ala	13.07	6	54.02	FS	24.21	65.27	C	Mul	4116	.43	Air
Nigata K6BA	R	DI	6-6.30x8.66	1617.7	115-750	13.0	4	540-750	853	75	54.6	868-750	6284	VI	2.12-.532	2.12-.532	20B	30AB	55BB	25A	CI	10.03	6	34.17	FS	17.32	28.6	C	Mul	4410	.42	Air
Nigata LH8X	R	TC	8-5.12x6.30	1037.0	200-2000	17.0	4	711-1500	853	77	13.2	687-1000	2646	VI	2.08-.571	2.08-.571	TC	48AB	40BB	8A	Ala	6.29	5	7.71	NS	11.81	11.47	C	Pin	1470	.43	Ele
Nigata LH6Z	R	TC	6-4.53x5.59	540.4	100-1600	17.0	4	711-1400	853	92	18.0	347-1200	1808	VI	1.81-.472	1.81-.472	TC	48AB	40BB	8A	Ala	5.82	5	.....	NS	11.41	.....	C	Pin	1470	.44	Ele
Nigata LH6T	B	PC	6-4.33x5.51	486.7	100-2000	17.0	4	569-1200	782	81	14.3	304-1200	1433	VI	1.77-.433	1.77-.433	TC	40AB	40BB	8A	Ala	5.90	5	4.85	NS	10.82	8.60	C	Pin	1470	.44	Ele
Nigata LH6S	B	TC	6-3.94x5.51	402.6	80-2000	15.0	4	569-1500	853	79	14.9	238-1300	1191	VI	1.57-.354	1.57-.354	5B	35AB	40BB	8A	Ala	5.03	4	3.75	NS	10.23	5.86	C	Pin	1470	.44	Ele
Nigata L6HRB	C	TC	6-3.54x4.72	279.3	75-2800	15.5	4	569-1500	853	76	11.5	181-1300	860	VI	1.41-.335	1.41-.335	5B	35AB	40BB	8A	Ala	4.72	4	2.64	NS	9.05	4.41	C	Pin	1470	.43	Ele
Nigata LH4S	T	TC	4-3.94x5.51	268.4	55-2000	15.0	4	569-1500	853	81	16.8	166-1100	926	VI	1.57-.354	1.57-3.54	5B	35AB	40BB	8A	Ala	5.03	4	3.75	NS	10.23	5.86	C	Pin	1470	.44	Ele
SWEDISH																																
Bolinder-Munktell (19) W3	M	PC	1-4.75x4.75	84.2	10-1000	.....	2	.....	....	47	.....	.....	.....	.....	.....	.....	Two	Cycle	.....	.....	CI	.....	.....	.....	.....	.....	.....	.....	Sin	.....	.....	H
Bolinder-Munktell W5	M,Tr	PC	2-5.87x5.87	318.5	30-900	.....	2	.....	....	42	.....	.....	.....	.....	.....	.....	Two	Cycle	.....	.....	CI	.....	.....	.....	.....	.....	.....	.....	Sin	.....	.48	A,E,H
Bolinder-Munktell (19) W7S4	M,Tr,R	DI	4-7.12x7.12	1135.5	100-900	.....	2	.....	....	39	.....	.....	.....	.....	.....	.....	Two	Cycle	.....	.....	CI	.....	.....	.....	.....	.....	.....	.....	Sin	.....	.....	A,E
Penta-Hesselman P63	M,R	DI	6-4.52x5.66	547.1	110-1800	6.2	4	142-1000	....	88	17.2	347-1000	1896	VI	1.89-.358	1.73-.358	2B	45AB	223B	170BB	Al	6.10	5	4.38	MS	11.81	6.91	O	Mul	850	.55	(x)
Scania-Vabis	T,B	DI	6-4.33x5.35	473.0	120-2200	6.2	4	142-	384	91	10.5	325-1000	1268	VI	1.96-.418	1.45-.418	TC	56AB	46BB	10A	Al	5.76	4	3.97	.....	11.02	5.95	O	Mul	2058	.53	Ele
Scania-Vabis	T,B	PC	6-4.33x5.35	473.0	120-2200	19.0	4	569-	853	91	11.0	325-1200	1323	VI	1.96-.418	1.45-.418	9B	37AB	46BB	10A	Al	5.98	5	4.41	.....	11.02	5.95	C	Pin	1249	.44	E(x)
Skandia 132DL	M,Tr,Ind	DI	2-5.11x7.48	307.4	30-900	14.0	2	483-900	640	86	73.5	.....	2205	...			Two	Cycle			....	9.96	..	.....	Stl	14.56	.....	C	Mul	3234	.36	A,E,G
Skandia 52	M,Tr,Ind	DI	2-6.69x5.51	387.9	30-800	8.0	2	199-800	313	77	70.5	.....	2117	...			Two	Cycle			....	10.23	4	.....	Stl	12.40	.....	O	Sin	955	.48	A,G
Skandia 26	M,Tr,Ind	DI	2-5.11x4.72	194.5	20-1000	8.0	2	199-1000	313	81	57.8	.....	1157	...			Two	Cycle			....	7.63	4	.....	Stl	9.44	.....	O	Sin	955	.53	H

Volvo-Hesselman	FAH	T,B	DI	6	4.12x5.11	408.7	115-2600	6.1	4	135-1000	390	86	10.4	300-1000	1200	VI	1.85-.472	1.49-.472	2B	51AB	224B	177BB	Ala	5.02	5	3.20	MS	10.23	4.67	O	Mul	850	.59	(x)
Volvo-Hesselman	FCH	T,B	DI	6	3.62x4.33	268.4	85-3000	6.2	4	135-1000	390	84	10.7	180-800	910	VI	1.61-.414	1.37-.414	2B	51AB	224B	177BB	Ala	4.60	5	2.07	MS	9.05	3.30	O	Mul	850	.62	(x)
SWISS																																	
Saurer	CAD	C,T,B	DI	4	3.15x4.72	147.0	43-2500	18.0	4	540-2500	996	93	13.9	94-2000	595	VI	1.06-.315	1.06-.315	12B	54A	57B	14A	Ala	4.72	5	2.29	NS	9.84	3.56	C	(e)	3560	.39	Ele
Saurer	CBD	C,T,B	DI	4	3.35x4.92	173.2	50-2500	18.0	4	540-2500	996	91	12.3	109-2000	617	VI	1.06-.315	1.06-.315	12B	54A	57B	14A	Ala	4.63	5	2.42	NS	9.84	3.56	C	(e)	3560	.39	Ele
Saurer	CRD	T,B	DI	4	4.13x5.12	274.5	55-1800	16.0	4	484-1800	853	88	17.0	174-1250	937	VI	1.18-.390	1.18-.390	5B	45A	45B	5A	Ala	5.98	5	4.65	NS	11.42	6.16	C	Mul	2560	.38	Ele
Saurer	CRID	T,B	DI	4	4.33x5.51	324.5	65-1800	16.0	4	484-1800	853	88	15.1	203-1250	981	VI	1.18-.390	1.18-.390	5B	45A	45B	5A	Ala	5.78	5	4.85	NS	11.42	6.16	C	Mul	2560	.38	Ele
Saurer	BOD	T,M	DI	4	4.33x5.90	347.7	76-1800	15.3	4	462-1800	853	97	17.4	246-1100	1323	VI	1.18-.358	1.18-.358	1B	45A	54B	10A	Ala	7.22	5	5.69	NS	13.39	9.90	C	Mul	2560	.38	Ele
Saurer	CCD	C,T,B	DI	6	3.15x4.72	220.8	72-3000	18.0	4	540-2500	996	86	10.4	137-2000	750	VI	1.06-.315	1.06-.315	12B	54A	57B	14A	Ala	4.72	5	2.29	NS	9.84	3.56	C	(n)	3560	.39	Ele
Saurer	CDD	C,T,B	DI	6	3.35x4.92	259.8	85-3000	18.0	4	540-2500	996	86	9.1	159-2000	722	VI	1.06-.315	1.06-.315	12B	54A	57B	14A	Ala	4.63	5	2.42	NS	9.84	3.56	C	(n)	3560	.39	Ele
Saurer	CTD	T,B	DI	6	4.13x5.12	412.3	85-2000	16.0	4	484-1800	853	82	13.4	260-1250	1135	VI	1.18-.389	1.18-.389	5B	45A	45B	5A	Ala	5.98	5	4.65	NS	11.42	6.16	C	Mul	2560	.38	A,E
Saurer	CTID	T,B	DI	6	4.33x5.51	486.8	105-2000	16.0	4	484-1800	853	85	11.2	289-1250	1179	VI	1.18-.389	1.18-.389	5B	45A	45B	5A	Ala	5.78	5	4.85	NS	11.42	6.16	C	Mul	2560	.38	A,E
Saurer	BLD	T,B,M,R	DI	6	4.33x5.90	521.5	105-1800	15.3	4	462-1800	853	89	16.4	369-1100	1720	VI	1.18-.358	1.18-.358	1B	45A	54B	10A	Ala	7.22	5	5.69	NS	13.39	9.90	C	Mul	2560	.38	A,E
Saurer	BUD	T,B,M,R	DI	6	4.72x6.69	703.9	140-1600	15.4	4	462-1600	853	99	16.5	499-1000	2315	VI	1.37-.452	1.37-.452	6B	50A	62B	18A	Ala	7.08	5	6.37	NS	14.17	10.98	C	Mul	2560	.38	Ele
Saurer	BXD	M,R	DI	6	5.12x7.08	874.1	180-1500	15.2	4	455-1500	853	109	13.5	658-1000	2425	VI	1.49-.452	1.49-.452	6B	50A	62B	18A	Ala	8.27	5	9.04	NS	14.17	12.94	C	Mul	2560	.36	A,E
Saurer	SAD	M,R	DI	6	5.90x7.87	1293.8	250-1500	15.2	4	455-1500	853	102	15.0	919-1000	3748	VI	1.81-.472	1.81-.472	5B	45A	45B	5A	Ala	8.66	5	11.79	NS	16.53	15.43	C	Mul	2560	.36	Ele
Saurer	BZD	M,R	DI	12	5.11x7.08	1748.8	360-1500	15.2	4	455-1500	853	109	13.5	1316-1000	4850	VI	1.49-.452	1.49-.452	5B	45A	45B	5A	Ala	8.27	5	9.04	NS	14.56	(f)	C	Mul	2560	.36	A,E

ABBREVIATIONS

(1)—Also built in 1, 2, 3 and 4 cylinder models
(2)—Also built in 4 and 6 cylinder models
(3)—Also built in 8 cylinder model
(4)—Also built in 6 cylinder model
(5)—Also built in 2, 3, 4, 5, 7 and 8 cylinder models
(6)—Also built in 2, 3 and 4 cylinder models
(7)—Also built in 2 and 3 cylinder models
(8)—Also built in 2 and 4 cylinder models
(9)—Also built in 2, 3, 4, 5 and 6 cylinder models
(10)—Also built in 3, 4, 5 and 6 cylinder models
(11)—Also built in 2, 3, 4, 5, 6 and 7 cylinder models
(12)—Also built in 1, 2, 3, 4 and 5 cylinder models
(13)—Also built in 4, 5, 6 and 7 cylinder models
(14)—Also built in V8 and V16 cylinder models
(15)—Also built in 4, 5, 7 and 8 cylinder models
(16)—Also built in 1 and 6 cylinder models
(17)—Also built in 4 cylinder model
(18)—Supercharged
(19)—Also built in 2 cylinder model
(20)—Also built in 2, 4 and 6 cylinder models
(21)—Also built in 6 and 12 cylinder models
(a)—Inner Rod 22 Lbs., Outer Rod 33 Lbs.
A—After top center (timing)
AB—After bottom center (timing)
AC—Air Chamber
A,E—Air or Electric
A,E,G—Air, Electric or Gas Engine
A,G—Air or Gas Engine
A,E,H—Air, Electric or Hand
A,H—Air or Hand
Al—Aluminum
Ala—Aluminum Alloy
Als—Aluminum with Strut
(b)—One Rod 11.22 long, one 24.96 long
B—Buses
B—Before top center (timing)
BB—Before bottom center (timing)
(c)—Primary 7.32—secondary 6.29
C—Cars
C—Closed (injection valve)
CI—Cast Iron
CM—Chrome-Molybdenum Steel
CN—Chrome Nickel Steel
CS—Carbon Steel
(d)—Primary 8.59—secondary 7.05
DA—Direct Injection with Air Chamber
DI—Direct Injection
DP—Direct Injection with Precombustion Chamber
(e)—Closed Annular Slot Type
Ele—Electric
(f)—Primary 24.45 Lbs.—secondary 13.47 Lbs.
FS—Forged Steel
H—Hand
H,E—Hand or Electric
H,E,I—Hand, Electric or Inertia
HI—Horizontally in Head (valves)
Ind—Industrial
M—Marine
MS—Manganese Steel
Mul—Multiple
NS—Nickel Steel
O—Open (injection valve)
PC—Precombustion Chamber
Per—Perlitic Iron
Pin—Pintle
R—Railcars
SA—Silicon Alloy
Sin—Single
SMa—Silicon Manganese Steel
Stl—Steel
SS—Single Sleeve type
T—Trucks
TC—Turbulence Chamber
TC—Top Center (timing)
Tr—Tractors
VI—Vertically in Head (valves)
(x)—For starting only, gasoline and spark ignition

University of Nebraska Tests Graham-Bradley Tractor

A TEST report on the Graham-Bradley tractor has been issued by the Agricultural Engineering Department of the University of Nebraska (No. 296). This is an all-purpose tractor manufactured by Graham-Paige Motors Corporation of Detroit. It is fitted with the Graham six-cylinder engine of 3¼-in. bore by 4⅜-in. stroke which has a governed speed of 1500 r.p.m. The inlet port has a diameter of 1⅜ in. and the exhaust port of 1 3/16 in. The carburetor is a Schebler 1-in., ignition is by the Delco-Remy battery system, the governor is a Handy of the centrifugal type. A Donaldson air cleaner of the oil-washed wire-screen-filter type is fitted. The clutch is a Long single-plate controlled by pedal. The transmission gives four forward speeds of 2.77, 4.42, 5.67 and 19.8 m.p.h. and a reverse speed of 2.03 m.p.h. (these being the advertised speeds). The belt pulley is of 15-in. diameter and 7¼-in. face, and turns at 714 r.p.m.

The chassis is of the tricycle type and is mounted on rubber tires. At the front there are dual wheels which are so inclined that their overall width is 8 in. at the bottom and 14½ in. at the top. The rear tread is adjustable between the limits of 56 and 84 in. The transmission and drive gears are completely enclosed. Front tires are 5.50 x 16 in., four-ply, and carry 20 lb. air pressure, while rear tires are 9.00 x 36 in., six-ply, and carry 14 lb. air pressure. To ensure sufficient traction, 50 lb. of iron and 120 lb. of water can be added per rear wheel. The tractor as tested weighed 4955 lb. with operator.

In the tests, the engine was operated on gasoline of 68-70 octane number and weighing 6.09 lb. per gallon. The lubricating oil was of No. 30 grade; 1.149 gal. was supplied to the engine and 1.056 gal. was drained from it, so that the consumption during the 43 hours the test lasted amounted to only 0.093 gal.

In the 100-per cent maximum load, two-hour test the engine developed 30.32 hp. at 1502 r.p.m. with a specific fuel consumption of 0.618 lb. per hp-hr. In the operating maximum load, one-hour test, the engine developed 28.27 hp. at 1497 r.p.m. with a specific fuel consumption of 0.586 lb. per hp-hr.

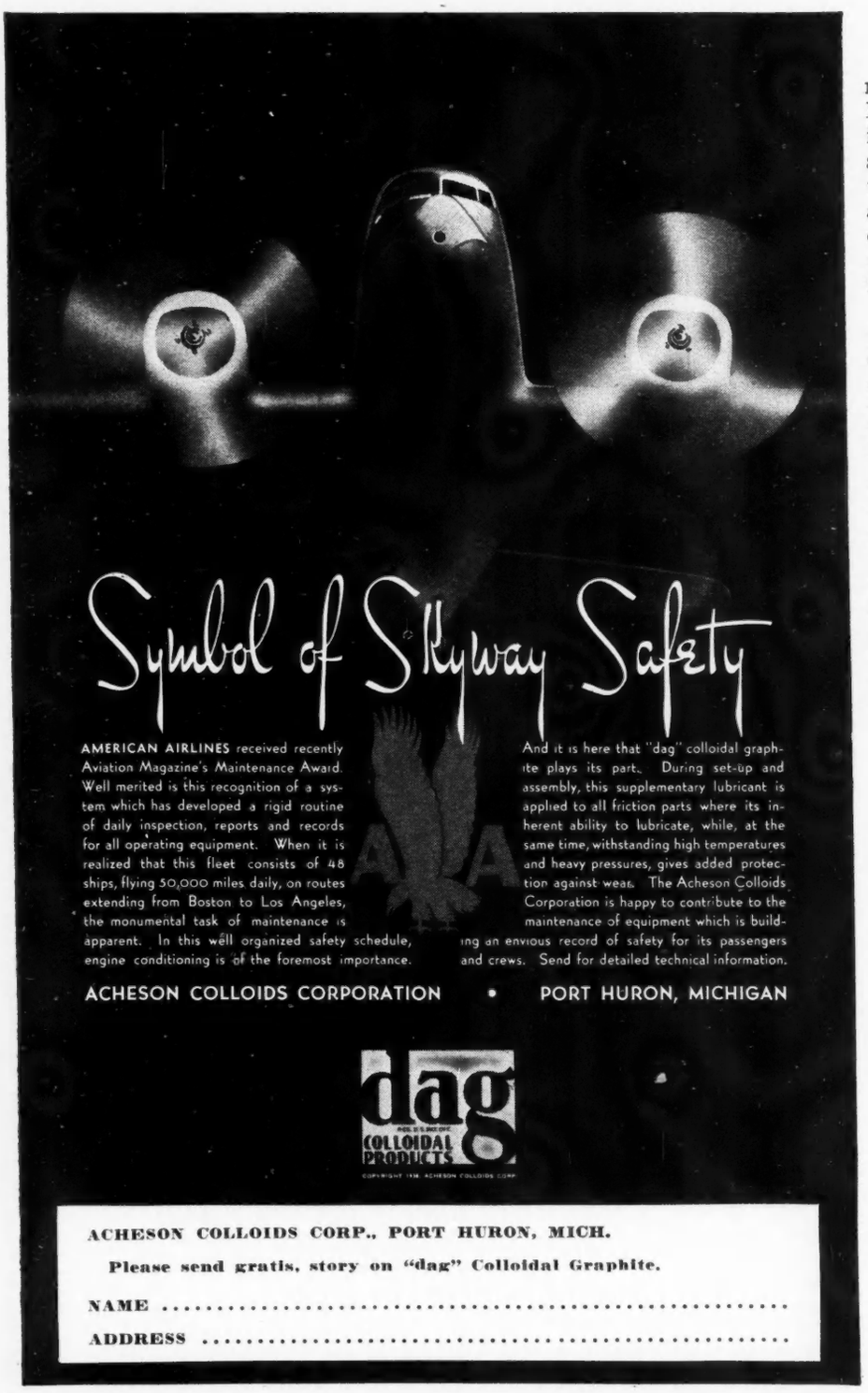
In the drawbar tests at operating maximum load the tractor developed a drawbar pull of 3013 lb. at 2.38 m.p.h. (19.11 hp.), 2163 lb. at 4.15 m.p.h. (23.92 hp.), and 1640 lb. at 5.49 m.p.h. (24.01 hp.). The operating maximum load tests were made with a carburetor setting selected by the manufacturer, giving 93.1 per cent of the maximum belt horsepower. The observed maximum horsepower was 25.20 on the drawbar and 30.38 on the belt. Corrected to sea level they were 26.49 drawbar and 31.75 belt. Under the new procedure the recommended ratings are 75 per cent of the calculated maximum drawbar horsepower and 85 per cent of the calculated maximum belt horsepower, which gives ratings for the tractor of 19.87 drawbar and for the belt 26.99 hp.

University of Michigan Laboratories

(Continued from page 722)

tributions has been in the field of sound research and reduction of noise in gears and mechanism as well as in the insulation of automobiles. For this purpose, they have made use of a special sound-proof chamber and a reverberation chamber, both of which are located in one of the isolated sub-basements.

Probably little is known publicly concerning the marvelous work of the Physics Department in the field of spectroscopy, particularly the spectrographic analysis of metals. Nevertheless, one of the most prominent foundries in the industry and one of the largest motor car manufacturers have taken advantage of the technical skill of the staff for the development of spectrographic equipment suitable for routine production testing. Barely a few years ago spectrographic analysis was considered merely a tool in pure research. Today, largely through the efforts of these investigators, the spectrograph has become a production tool effecting savings of several hundred dollars per day in the foundry. Moreover, as the newly developed techniques become better known they should find a wide acceptance wherever metals and alloys are used in large quantity.


Symbol of Skyway Safety
AMERICAN AIRLINES received recently Aviation Magazine's Maintenance Award. Well merited is this recognition of a system which has developed a rigid routine of daily inspection, reports and records for all operating equipment. When it is realized that this fleet consists of 48 ships, flying 50,000 miles daily, on routes extending from Boston to Los Angeles, the monumental task of maintenance is apparent. In this well organized safety schedule, engine conditioning is of the foremost importance.
And it is here that "dag" colloidal graphite plays its part. During set-up and assembly, this supplementary lubricant is applied to all friction parts where its inherent ability to lubricate, while, at the same time, withstanding high temperatures and heavy pressures, gives added protection against wear. The Acheson Colloids Corporation is happy to contribute to the maintenance of equipment which is building an envious record of safety for its passengers and crews. Send for detailed technical information.
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Catapult Mathematics

(Continued from page 731)

moved, catapult it into the air. The Friesenland can handle planes weighing up to 18 long tons, and to get such a heavy mass up to a speed at which it can sustain itself in the air, in the short distance available on the deck of the ship, naturally requires an enormous accelerating force.

The catapult comprises an operating cylinder of 26¾ in. diameter containing a piston having a stroke of 17.7 ft. By means of block and tackle the distance through which the accelerating force is applied is multiplied by six. During a travel of 103.7 ft. an acceleration equal to three and a half times that of gravity is given to the seaplane, which in 1.52 sec. acquires a speed of 94 m.p.h. The total length of the catapult is 136.3 ft. Not all of the length can be used for accelerating the seaplane, because the carriage must be brought to a stop, and for this 18.9 ft. is allowed.

Same Prize—Same Hopes

The same as in previous years, the French Government has instituted a prize of one million francs to encourage the construction of racing automobiles in France. Last year the prize was awarded to Delahaye, whose vehicle was the only one that came near satisfying the conditions imposed with respect to speed and stamina. This year three makes are in line for the award, viz., Delahaye, Talbot, and Bugatti.

Just Think of It!

According to H. H. Franck, formerly professor at Berlin Technical College, 40,000 inorganic compounds have been produced in the laboratory, of which about 250 are produced on a quantity basis; and there are known to chemists about 250,000 organic compounds, of which industry produces about nine thousand.

UNLOCKING NEW DIESEL MARKETS WITH

NICKEL

BEST NEW CAR SALESMEN are new highways, built with Diesel power. Power made dependable by liberal application of Nickel alloy steels as in this husky tractor. A table of typical Diesel applications is listed below.

PART	TYPE OF STEEL	COMPOSITION C	Mn	Ni	Cr	Mo	TREATMENT	SERVICE REQUIREMENTS (*)
Connecting Rods, Piston Rods, Crossheads	SAE 2330	.30	.75	3.50			Quenched and Drawn	Strength with high degree of toughness and ductility.
Piston Pins, Crosshead Pins	SAE 3120	.20	.45	1.25	.60		Case Hardened	Wear resistant surface with strength in the core.
Frame Bolts, Tie Rods, Staybolts, Cylinder Head Studs, Connecting Rod Bolts, etc.	SAE 4340	.40	.65	1.75	.65	.35	Quenched and Drawn	Strength with a high degree of toughness and ductility.
Crankshafts	SAE 2330	.30	.75	3.50			Quenched and Drawn	Strength, toughness, and good fatigue resistance.
Crankshaft Pinions	SAE 3130	.30	.75	1.25	.60		Quenched and Drawn	Strength with a high degree of wear resistance.
Exhaust Valves, Seats	Ni-Cr-Mo	.40	.75	1.25	.60	.20	Quenched and Drawn	Resistance to elevated temperatures and corrosion by exhaust gases.
Exhaust Valve Spindles	SAE 3250	.50	.45	1.75	1.10		Special Heat Treatment	Strength with a high degree of toughness and ductility.
Intake Valves	21—12			12.0	21.0		Quenched and Drawn	Moderate strength, resistance to wear and deformation.
Camshaft	SAE 2330	.30	.75	3.50			Quenched and Drawn	Wear resistant surface with toughness in the core.
Camshaft Gears, Timing Gears, etc.	SAE 3140	.40	.75	1.25	.60	....	Case Hardened	Strength with a high degree of wear resistance.
Cams, Cam Integral, Cam Roller	SAE 2315	.15	.45	3.50			Quenched and Drawn	High degree of wear resistance with toughness and strength in the core.
Valve Rockers	SAE 3250	.50	.45	1.75	1.10		Case Hardened	Strength with a high degree of toughness and ductility.
Push Rods	Ni Cr (Krupp)	.17 max		4.00	1.50		Quenched and Drawn	High compressive strength and toughness.
Fuel Oil Pump Plunger, Barrel, Valve Plunger, Valve Barrel	SAE 2330	.30	.75	3.50			Quenched and Drawn	High degree of wear resistance with strength and toughness in the core.
Fuel Oil Pump Lever	SAE 4340	.40	.65	1.75	.65	.35	Quenched and Drawn	Wear resistant surface with strength and toughness in the core.
Fuel Oil Pump Camshaft	SAE 2345	.45	.75	3.50			Case Hardened	Wear resistant surface with toughness in the core.
	Ni Cr (Krupp)	.17 max		4.00	1.50		Case Hardened	
	SAE 3215	.15	.45	1.75	1.10		Case Hardened	
	SAE 2315	.15	.45	3.50				

* The remarks under "Service Requirements" serve to give a rough indication of the reasons underlying the choice of these steels. Individual characteristics of engine design and factors concerned with the economics of fabrication also play an important part in the selection of suitable materials.

Nickel alloy steels overcome higher operating temperatures and higher working pressures. Our experience through years of Diesel growth is yours for the asking.

DIESEL POWER for a thousand tasks beyond electric power lines—refrigerating trucks, operating pumps and supplying light and power for small factories, farms and filling stations—is now practical with new small Diesels using Nickel alloy steels. Your consultation is invited.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N.Y.